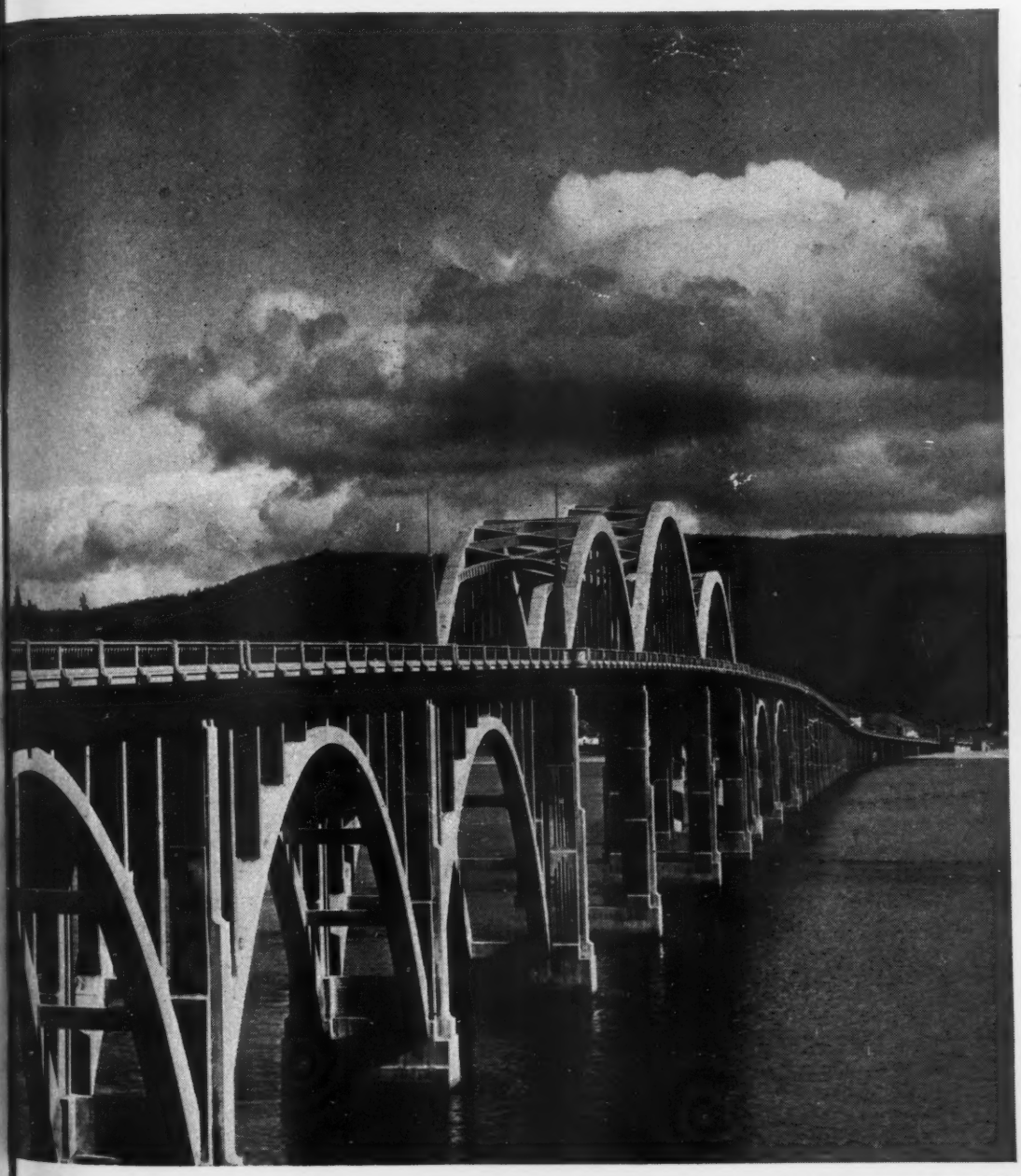
Compressed Air Magazine

APRIL 1944



ALSEA BAY BRIDGE, OREGON

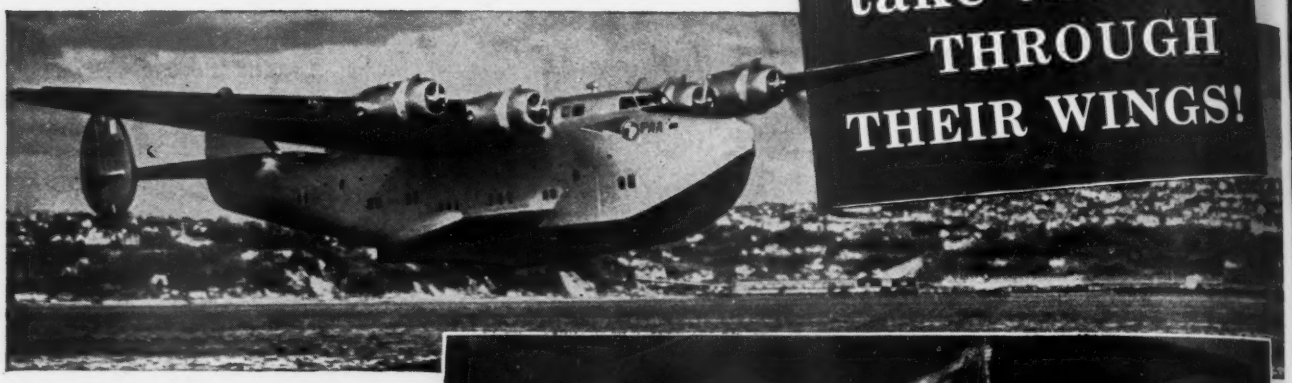
This structure on the main coastal highway, U. S. 101, is near the town of Waldport.

VOLUME 49 • NUMBER 4

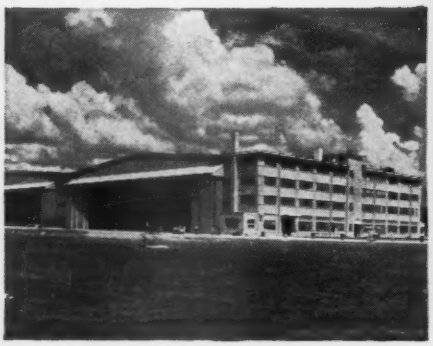
NEW YORK • LONDON

Pan Am Clippers

take the air THROUGH THEIR WINGS!



HOW would *you* like working inside the wing of a plane where air seems to be rationed by the cubic inch? Ever fit an ornery part there while the sweat runs into your eyes and off the end of your nose? If you haven't — try it sometime — you'll understand why 100% efficiency is utterly impossible under such conditions.



Coppus Ventilator furnishing fresh air to wing compartment

This problem has been solved by Pan American World Airways at its new million-dollar Miami hangar, one of the largest in the world. Here Coppus Ventilators supply fresh air to employees working in confined compartments, fuselages and wings. These same Coppus Ventilators are used for field service, too.

Pan American is one of many leading airlines using portable Coppus Blowers and Exhausters to step up production wherever bad air or heat threatens health and efficiency. And Coppus Blowers are used even to inflate barrage balloons for testing seams.

At low cost, you, too, can bring to workers a continued supply of invigorating cool air. The "Blue Ribbon" (a blue band) is your assurance of quality performance at lowest cost. Send for specific information on Coppus Blowers and Exhausters for cable manholes, tanks, shipholds and general man-cooling. Use the coupon.

MAIL COUPON To Coppus Engineering Corp., 554 Park Ave., Worcester 2, Mass.

PLEASE SEND ME INFORMATION ON SUPPLYING FRESH AIR TO MEN WORKING:

A COPPUS
"BLUE RIBBON" PRODUCT

DESIGNED FOR YOUR INDUSTRY
...ENGINEERED FOR YOU

- ☐ in aeroplane fuselages, wings, etc.
- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ on boiler repair jobs.

Other Applications:

- ☐ general man-cooling.
- ☐ cooling motors, generators, switchboards.
- ☐ exhausting welding fumes.
- ☐ freshening air where men are working or material is drying.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....

Write here any special ventilating problem you may have .....

.....

World's Largest Internal Combustion Engine Power Plant is Completely Equipped with

STAYNEW AIR FILTERS

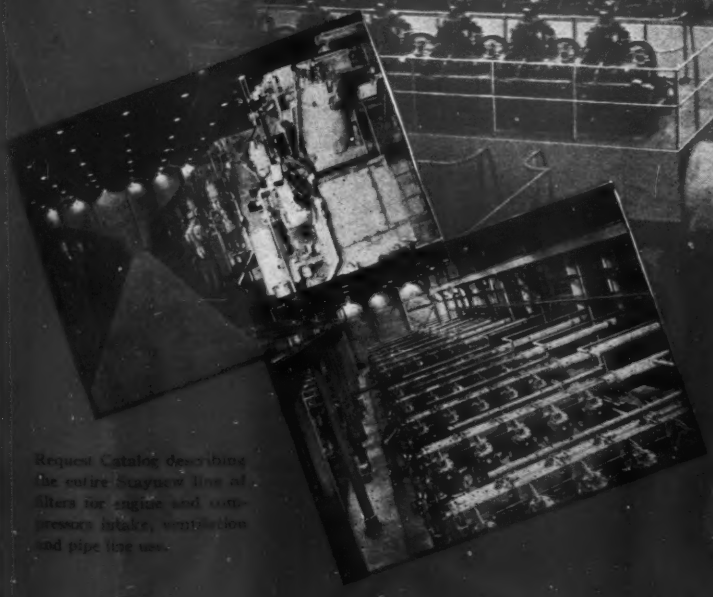
Total Horsepower: 123,050

Number of Engines: 68

Total Combustion Air Requirements: ..... 588,000 CFM

Every Engine is Staynew Filter Protected—Setting Another World's Record, Since This Is The World's Largest Intake Air Filter Installation.

INTAKE SILENCER-FILTER



Request Catalog describing the entire Staynew line of filters for engine and compressor intake, ventilation and pipe line use.

STAYNEW FILTERS ALSO CHOSEN FOR OTHER APPLICATIONS

. . . Staynew Intake Filters for general plant compressed air and Staynew Automatics for engine room ventilation systems. Again, past experience with Staynew Filters was responsible for their exclusive selection.

STAYNEW FILTERS — PROTECTOMOTOR

Filter Headquarters

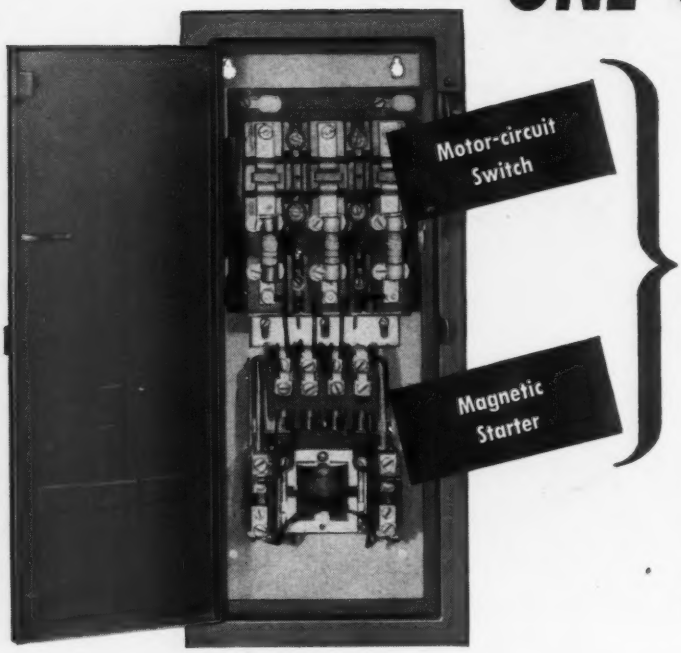
DOLLINGER CORPORATION

(Formerly Staynew Filter Corp.)

2 CENTER ST., ROCHESTER 4, N.Y.

EVERYTHING YOU NEED

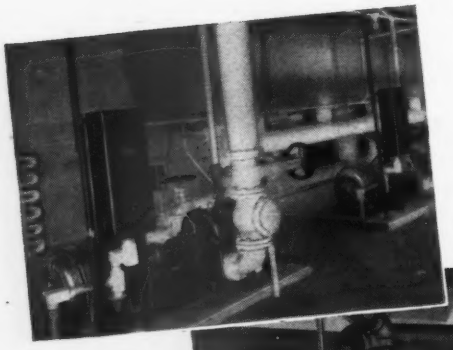
to control and protect your motor in ONE COMPACT UNIT



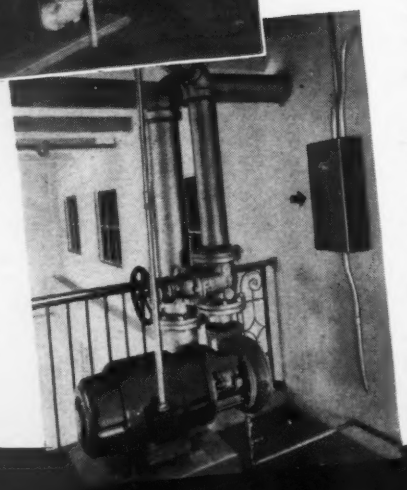
COMBINATION STARTER

Complete full-voltage control of squirrel-cage motors or the primary control of wound-rotor motors—with extra safety, very low installation cost, good appearance, and other advantages

Why two devices? ONE can do the job.



G-E combination starters can be mounted on or near the machine, even in damp locations, such as shown in this pump-room installation



This combination starter drives a ball-bearing splash-proof motor direct-connected to a centrifugal pump

Which Type Do You Need?

If you want short-circuit protection, you can select a starter which has a fusible motor-circuit switch or a breaker to provide such protection. Or, if you do not need short-circuit protection, you can choose a starter which is equipped with a nonfusible motor-circuit switch that serves only as a disconnect and provides no short-circuit protection. Both types are available in a variety of enclosing cases.

Co-ordinated for Protection

With G-E combination starters, you're sure that the motor-circuit switch or breaker has the proper rating for the magnetic starter with which it is used. The fuses or breakers provide adequate short-circuit protection to the motor, the starter, and subsequent motor-branch-circuit conductors when connected to a power supply for which they are recommended. The co-ordination of thermal overload relays with the fuses or breakers affords complete motor overcurrent protection under any condition of operation.

Increased Safety

The motor-circuit switch, being in the same case with the magnetic starter, is mechanically interlocked with the cover. Thus the cover cannot be opened while there is power on the starter. This is an important advantage because, when a separately mounted switch and starter are used, there is nothing to prevent the operator from opening the starter case while the starter is "hot."

WANT MORE DATA?

More complete information on combination starters will be found in Bulletin GEA-3715. Ask our nearest office for this bulletin or write direct to General Electric Co., Schenectady 5, N. Y.

Every week 192,000 G-E employees purchase more than a million dollars' worth of War Bonds.

GENERAL ELECTRIC

FACE LIFTING

WHETHER "lifting" the face of a mountain, boring a tunnel, building Army and Navy bases or airport runways, one of a contractor's first considerations is Compressed Air.

Air compressor operators everywhere are getting continued trouble-free performance by lubricating with *Texaco Alcaid, Algol* or *Ursa Oils.*

Texaco Alcaid, Algol or *Ursa Oils* assure wide-opening, tight-closing valves, free piston rings, open ports, clear lines. Their use assures maximum service life between overhauls, fewer repairs and replacements.

So effective have Texaco lubricants proved that they are definitely preferred in many fields, a few of which are on the right.

Texaco Lubrication Engineering Service is available to you through more than 2300 Texaco distributing points in the 48 States. The Texas Company, 135 East 42nd St., New York 17, N. Y.

THEY PREFER TEXACO

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.

★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

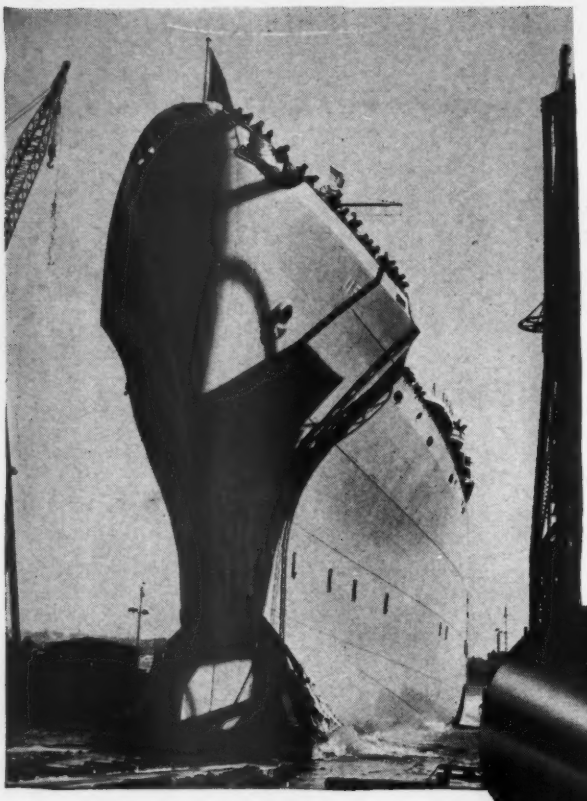
★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

TEXACO

TEXACO Lubricants and Fuels

FOR ALL CONTRACTORS' EQUIPMENT

TUNE IN FRED ALLEN EVERY SUNDAY NIGHT – CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY



There goes 3½ Miles of Victaulic Coupled Pipe

When the tremendous war shipbuilding program got under way . . . there was one headache America's shipbuilders *didn't* have. That was how to tackle the problem of coupling sea-going pipe in a hurry. For many years the proven answer had been Victaulic. Watch almost any Liberty ship, tanker, or other vessel being put together in record speed and you'll see why. It's the fastest method to couple pipe! It's a method the vast new army of shipyard labor can understand and use without previous training or experience. It saves space, saves weight . . . and you wind up with a flexible system of piping in which damaged pipe can be replaced quickly and easily.

(1) Fast Self-Aligning permits angular deflection!

(2) Leak-tight, self-sealing under pressure or vacuum!

(3) Positive mechanical lock of pipe lengths!

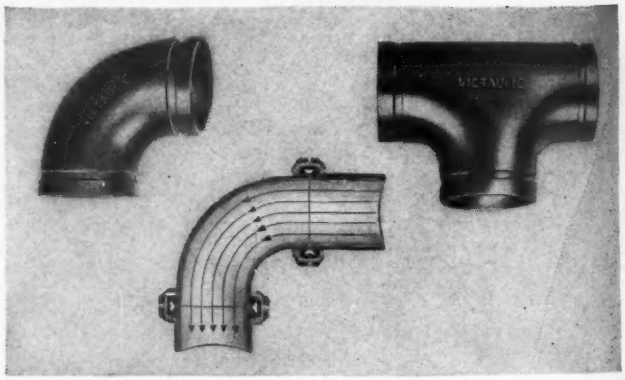
(4) Every joint is a pipe union!

(5) Every joint an expansion joint!

(6) Available for all pipe sizes ¾″ through 60″!

SPECIAL VICTAULIC ADVANTAGES FOR INDUSTRIAL USERS!

- ★ Can be installed faster and with less labor than any other method!
- ★ Lower installation costs . . . unskilled labor can do the job.
- ★ No expensive equipment needed . . . one small wrench is the only tool required.
- ★ Substantial savings in space and weight.
- ★ Temporary lines can be salvaged 100 percent. Maintenance is nil!



TWO GOOD EXAMPLES OF WHY YOU SAVE WITH VICTAULIC FULL-FLOW FITTINGS. Accurately machined, streamlined inside and out. Note the smooth, unobstructed flow. Engineered to give you increased delivery at lower pumping costs. Be sure to specify Victaulic Full-Flow Fittings wherever you use Victaulic Couplings.

VICTAULIC

Reg. U. S. Pat. Off.

SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

BUY MORE WAR BONDS!

JUST OFF THE PRESS . . . the new Victaulic Catalog and Engineering Manual. Send for your copy today.

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*Address*_____

Mail to nearest address: VICTAULIC COMPANY OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y.; Victaulic Inc., 727 West 7th St., Los Angeles 14, California; Victaulic Co. of Canada, Ltd., 200 Bay St., Toronto. 6F

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GIVE YOUR CONCRETE A BREAK

USE

Cushioned-Air Paving Breakers at work. CC-80 left; CC-60 right.

Cushioned Air PAVING BREAKERS

"Cushioned-Air" permits use of Greater Power and Results in ... Lower Upkeep Costs ... Easier Holding ... More Work Done

You have "Cushioned-Air" in the Ingersoll-Rand CC-60 (60 pounds) and CC-80 (80 pounds) Paving Breakers. It prevents the piston from hitting the fronthead... there is less shock... more power is packed into the breaker... upkeep costs are lower. Moreover, because of the "Cushioned-Air" principle, tiring jolts are not transmitted through the machine to the operator's hands and arms. Easier holding results, especially at higher air pressures, and more work is done.

No wonder "Cushioned-Air" Paving Breakers are standard equipment with so many contractors, utilities, and maintenance crews. Be sure that your next paving breakers are "Cushioned-Air." Ask the Ingersoll-Rand Service Division nearest you for complete details.

Ingersoll-Rand

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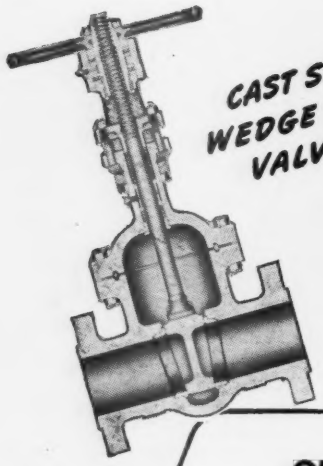
5-393

COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

Power or Process Piping Systems CRANE can equip them 100%

Pipe
Pipe Bends, Flanged and Welded
Automatic Stop Check Valves
Pipe Supports
Gaskets and Studs
Gate Valves
Globe Valves
Flanges
Reducers
Screwed Fittings
Flanged Fittings
Welding Fittings
Fabricated Piping
Separators
Gauges
Safety Valves
Steam Traps
Unions
Union Fittings



CAST STEEL WEDGE GATE VALVES

Steam Piping for Double-Boiler Hook-up

ONE STANDARD OF QUALITY

The whole system is more dependable because there's one high standard of quality—adequate for the need—in every part. In Crane Steel Gate Valves, for example: Straight-through ports minimize turbulence, erosion, resistance to flow. Strong tee-head disc-stem connection, ball-bearing yoke, and non-corrosive stem bearings assure smoothest operation. Adequate stem power and extra long disc guides make seating positive.

ONE SOURCE OF SUPPLY . . . ONE RESPONSIBILITY FOR ALL MATERIALS

Only a source as complete as Crane can give you these advantages. For power, process, or any other piping system—not only the valves and fittings, but every part, from pipe to gaskets and studs, are regularly available from Crane. Where else, but in the world's greatest line of piping materials, could you expect a selection of equipment that always meets your needs—of quality that's always dependable? For, back of it stands Crane Co.'s 89-year leadership in the piping field. CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill.

CRANE

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

HOW TO SOLVE
Operating Problems with *Correct Lubrication*

Gargoyle Almo Oil No. 3 Helps Operators Get Maximum Footage

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION

New Type Oil Stops Stalling!

WITH Almo Oil No. 3, Socony-Vacuum's new type rock drill oil, it's practically impossible to stall the drill tool. In recent tests, veteran drillers tried repeatedly in vain.

The secret of this amazing resistance to stalling lies in the combination of properties built into the oil. Strong films resist rupture under shock loads and protect the rifle bar and other moving parts from metal-to-metal contact. High resistance to the washing effect of water keeps films on the job even in damp surroundings.

Also important is this oil's high chemical stability. It assures freedom from gummy deposits—hence, fast-acting valves. Correct body means maximum drill speeds. There are no objectionable odors, fog, or eye-burning effects.

GARGOYLE Lubricants

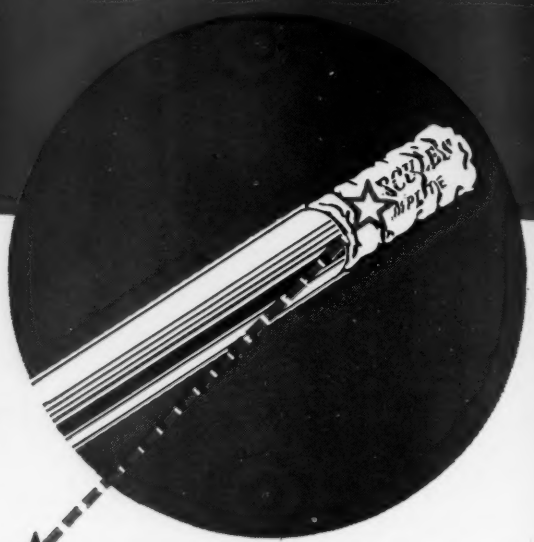
SOCONY-VACUUM OIL CO., INC., Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California.

CALL IN SOCONY-VACUUM

TAMPTITE

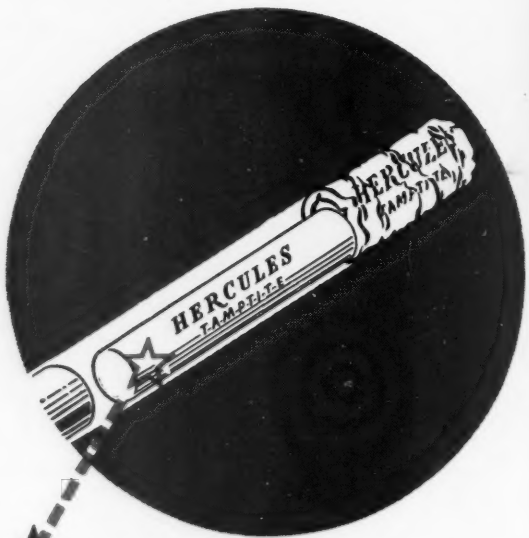
SAVES TIME · SAVES LABOR · PACKS SNUGLY · GIVES BETTER BREAKAGE

1 **FASTER LOADING** of bore holes is possible with Tamptite because there is no wasted time splitting cartridges, no fuss or bother. You simply insert a Tamptite cartridge and tamp.



2 **TIGHTER CHARGING** is bound to result because both dynamite and the Tamptite wrapper expand to fill the bore hole tightly, snugly. Virtually no air space remains around the charge.

Order your favorite Hercules explosives in Tamptite cartridges. All the customary grades and sizes of Hercules Gelamites*, Hercomites*, Extra Gelatins, Gelatins, and Extra Dynamites are available in this time-saving wrapper.



3 **BETTER BREAKAGE** of the ore or rock occurs because the entire charge is concentrated exactly where you want it. The result is speedier mucking and a faster mining cycle.

HERCULES
EXPLOSIVES

HERCULES POWDER COMPANY INCORPORATED ..... 932 KING STREET · WILMINGTON 99, DELAWARE

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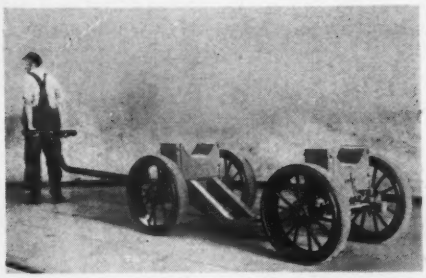
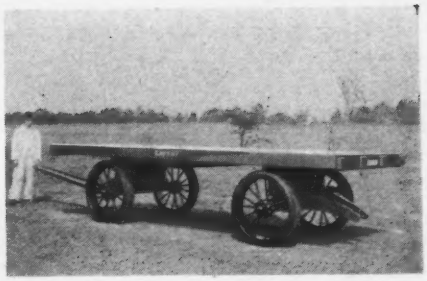
XR-42

ORDER HERCULES EXPLOSIVES IN TAMPTITE CARTRIDGES

1. TRAILER FOR PICKLING BASKETS



2. REVERSIBLE TRAILER FOR CRANK SHAFT

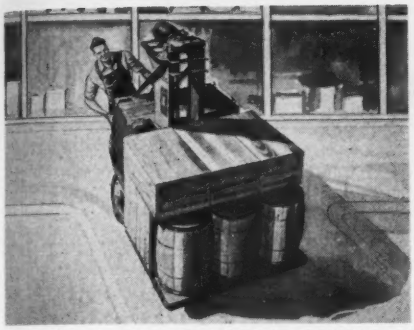


3. 10-TON PLATFORM TRAILER

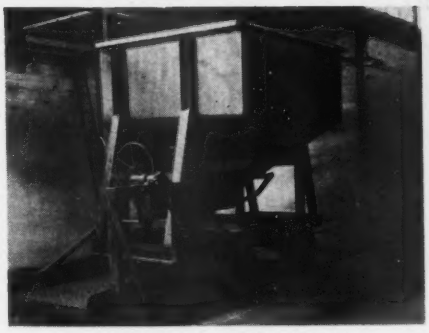
4. 15-TON FRAME CAR

5. 50-TON CAR

6. 15-TON PLATFORM CAR



7. TIER-LIFT STORAGE BATTERY POWER TRUCK

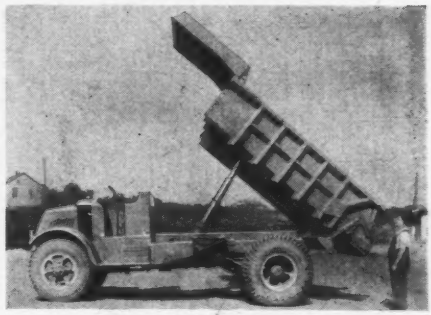


8. 150 CU. FT. CHARGING CAR

9. UNDERGROUND MINE CAR

10. BODIES FOR SIDE DUMP ORE TRUCKS

11. SEMI-TRAILER (TRACKLESS MINE CAR)



12. 9-YD. QUARRY BODY AND HOIST

ENGINEERED TRANSPORTATION IS OUR *Business*

Each of these trailers, cars and trucks is serving the varied transportation operations of one war industry—a large corporation vital to war production. All of them were engineered and built by EASTON. Some are standard models, while others were designed to meet specific problems. Still, these views show but a few of the hundreds of different types of EASTON handling equipment. Here is a wealth of "know-how" that makes EASTON your materials-handling headquarters. For information on how your handling problems might be solved, write to: Engineering Counsel, Easton Car & Construction Company, Easton, Pennsylvania.

EASTON

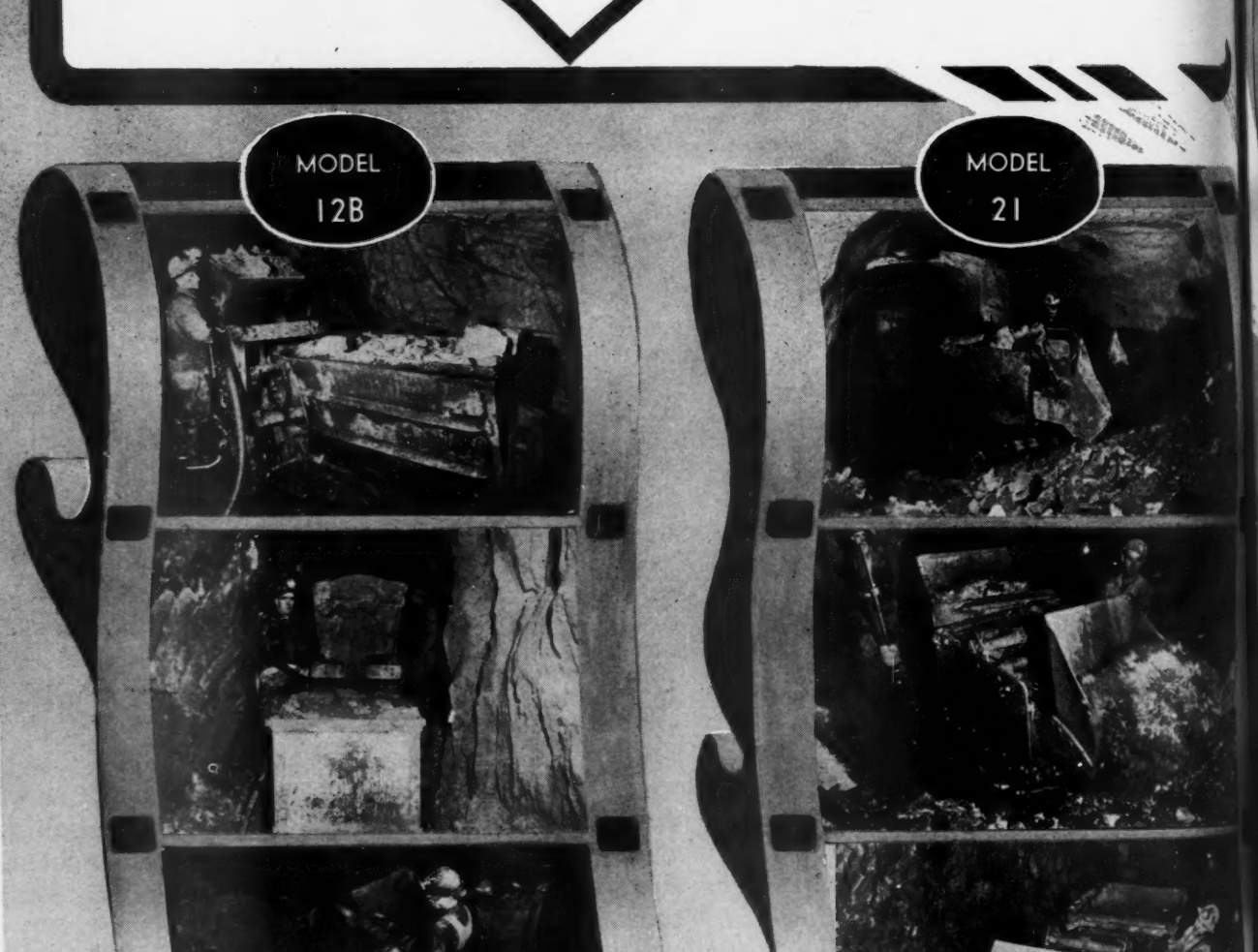
INDUSTRIAL CARS
TRUCK BODIES · TRAILERS
ELECTRIC LIFT TRUCKS

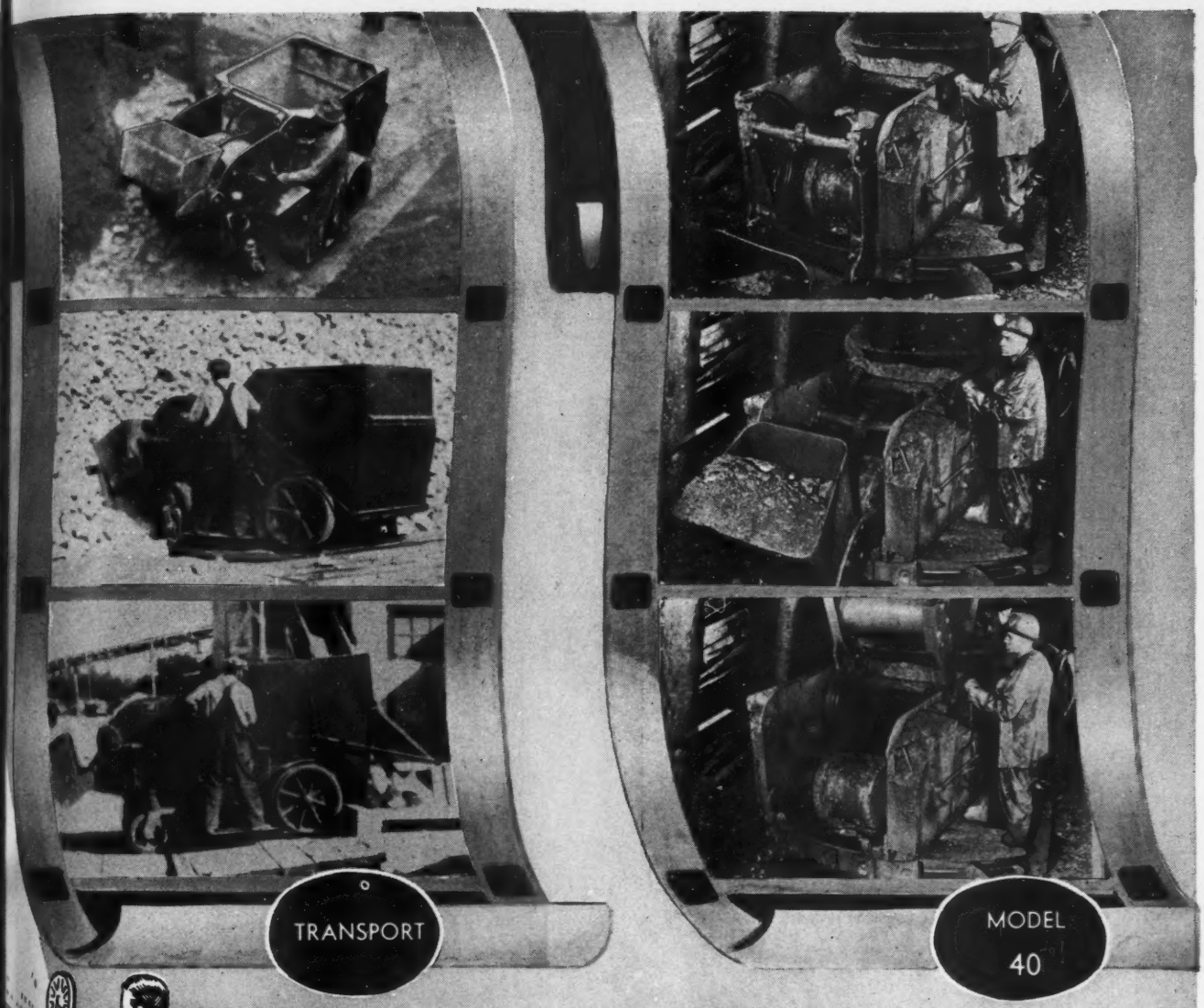
A—1005

Announcing

our new name and trademark

Eimco RockerShovel





Because the Eimco Rocker Arm is fundamentally a basic mechanical principle that insures simplicity of design, maximum leverage and conversion of applied power, it has invited imitations by competitive manufacturers. No manufacturer can duplicate the Eimco Rocker-Arm action without infringing Eimco owned patents.

Eimco has been able to make its progress in material loading with a succession of loader Models that have achieved remarkable results in their respective fields. From its first small mine-car-loader to its massive Tunneloader and to new Models, for surface loading, now on its drafting tables the Eimco Rocker-Arm principle is the feature that assures success. Therefore, to adequately protect the user and to thoroughly identify the genuine Eimco product we have adopted and registered the trademark "RockerShovel".

The Eimco "RockerShovel" since its introduction to the mining world in 1932, has been the pioneer in mechanical loading, it has made "hand-mucking" as obsolete as hand-drilling. Through its new methods for track advance, car-servicing and loader use, Eimco has revolutionized the handling of muck and ore so that today hundreds of "RockerShovels" are in operation wherever mining is being done. If its an Eimco "RockerShovel", whether underground or on the surface, you can depend on its being the champion.

EIMCO

THE EIMCO CORPORATION, SALT LAKE CITY 8, UTAH
NEW YORK, 120 BROADWAY — SACRAMENTO, 1217 7TH ST
CHICAGO, 111 W. WASHINGTON ST. — EL PASO, MILLS BUILDING

Outstanding Wheels
for Steel Castings . . .
NORTON RESINOID
14/2-P4T-L for Swing Frames
14/2-O4T-L for Floor Stands
These recommendations are based on medium pressure and medium contact. Light pressure or large contact would mean slightly softer wheels while heavy pressure and small contact would call for somewhat harder grades.
In each case you are sure of a snagging wheel that's engineered for its job—special resinoid bond formulae developed by Norton research for foundry grinding plus Alundum abrasive especially selected for snagging work.
There are also Norton Resinoid Wheels of Cyrstolon abrasive for gray iron and unannealed malleable castings. Call on your Norton abrasive engineer for recommendations.
NORTON COMPANY
Worcester 6, Mass.
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NORTON ABRASIVES

ON THE COVER

THIS month's picture shows a concrete bridge across the estuary of the Alsea River, which flows into the Pacific Ocean. The channel crossing consists of one 210-foot and two 154-foot through-tied arches. The approach sections are made up of 150-foot deck arches. The total length of the bridge is 3028 feet, or almost three-fifths of a mile. It carries a 24-foot roadway and two 3½-foot sidewalks and is operated toll-free. Before it was erected, motorists had to cross the bay by ferry. The photograph was taken by Russel G. Knight of El Paso, Tex.

•

IN THIS ISSUE

ALL the fighting ships that we build must be serviced regularly, and the rapid growth of our Navy has consequently called for a corresponding increase in our dry-dock facilities. Moreover, many of our battle craft are now constructed in docks instead of on ways, there being many advantages in this. Our naval engineers, with the aid of civilian specialists, have developed an effective technique for building dry docks underwater. It is described by Robert G. Skerrett.

•

METHODS of moving dirt and rock in railroad construction have undergone a complete transformation within a single life span. The contrasting procedures on two prominent intermountain rail systems that were built in different eras are pointed out in *Echoes of Western Railroad Construction.*

•

NIGHT and day, since last December, each of fourteen centrifugal pumps has been discharging a 24-inch stream of water from Steep Rock Lake in Canada, lowering its surface to give access to submerged iron-ore deposits. This is reputed to be the largest pumping job ever scheduled in connection with a mining operation. An article that starts on page 99 gives the details.

•

A NOVEL scheme of drilling lime kilns right in the stone that is burned in them is successfully employed in Utah and is described by the engineer in charge.

Compressed Air Magazine

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VOLUME 49 **April, 1944** NUMBER 4

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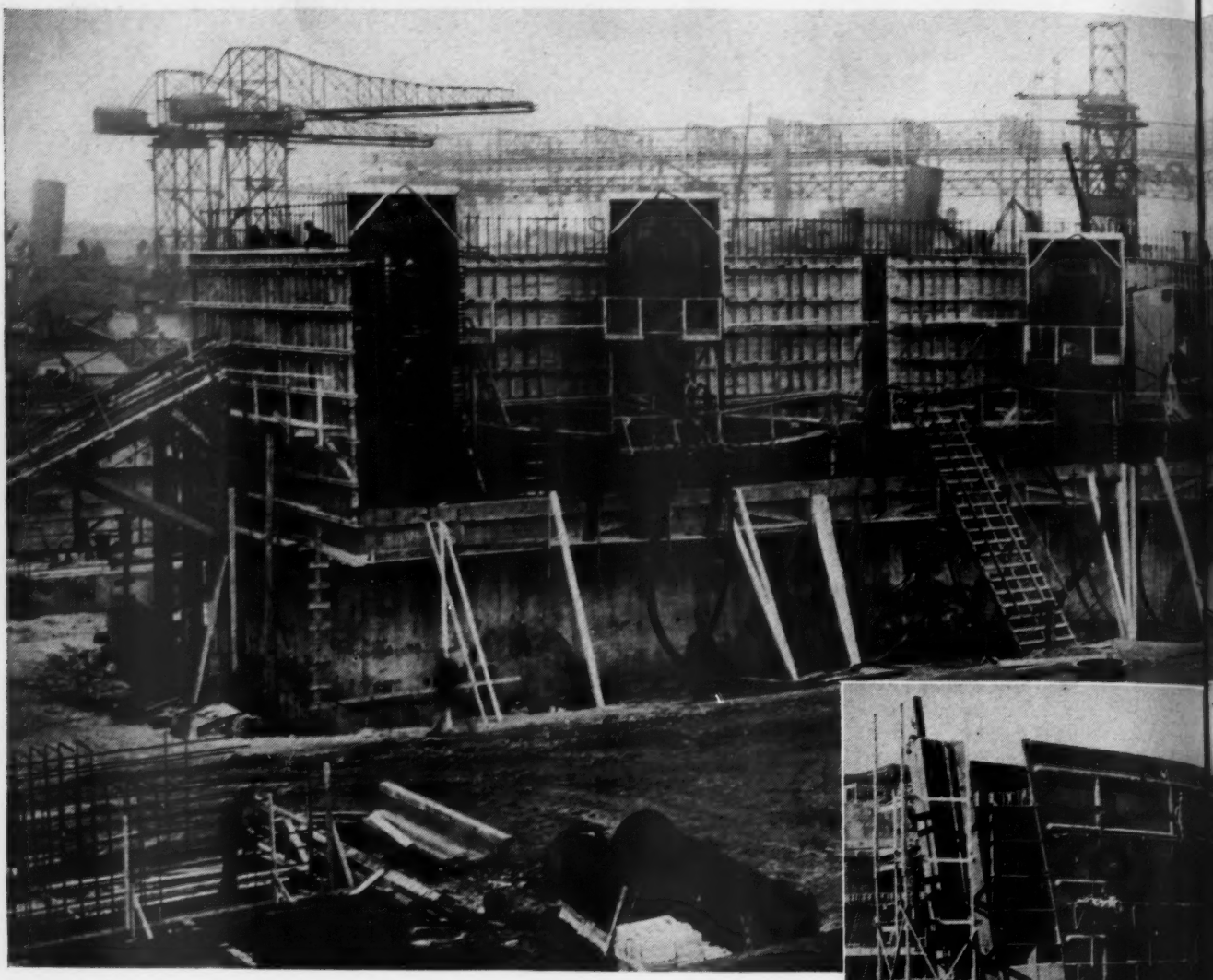


Official U. S. Navy Photos

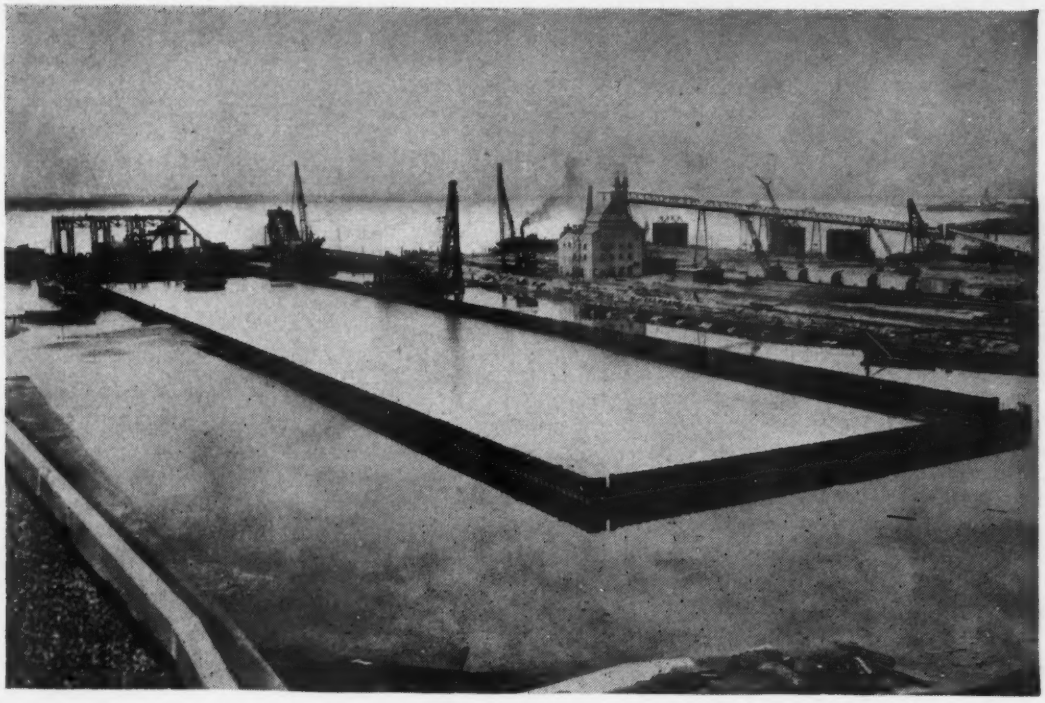
OUR *New* NAVY DRY DOCKS

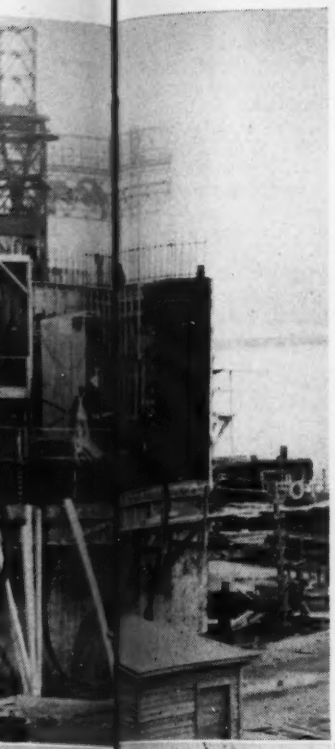
Robert G. Skerrett

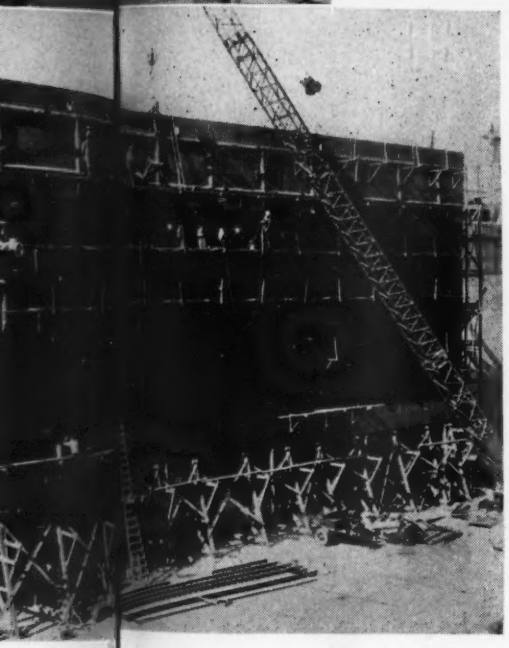
EVER so often, even in normal times, every fighting ship must be dry-docked. Damages due to combat and the need of prompt refitting for return to sea service may markedly shorten the intervals between docking. Keep these facts in mind. Also remember that the demands for dry-docking are directly proportional to the number of active vessels in the battle fleet, to the circumstances of their employment, and to their aggressive contacts with our enemies.

At the end of 1942 the U. S. Navy had 419 combatant ships of various classifications. By the close of last November—in eleven months, to be exact—the number had been doubled, and that increase was exclusive of the auxiliaries, patrol, mine, and landing craft built within the same period. During 1943, American shipyards—Government and private—turned out 1,000,000 tons of fighting vessels; and while engaged in replacing the 21 warships lost from our battle line during that year brought the fleet of the nation up to the magnificent strength of more than 838 ships. Nearly every one of those vessels had to be dry-docked before going to sea for the first time; and dry docks had to be available whenever their hulls had to be bared for examination, repair, or for cleaning and repainting so that each craft could slip through the water and make the most of the propulsive power of her driving engines. These facts are elementary, but are lost sight of by the public at large in the spectacular war performances of our ships.

About five years ago Congress made provision for a 20 percent increase in our battle fleet. To equip us with shore facilities to take adequate care of the many-sided services demanded by such a Navy it was necessary to appropriate hundreds of millions of dollars and to construct numerous dry docks. Admiral William D. Leahy, U.S.N., then Chief of Naval Operations, called attention to the great need of such facilities in a hearing held at that time before a congressional committee. He said: "The importance of maintaining our shore







STEPS IN CONSTRUCTING A GRAVING DOCK

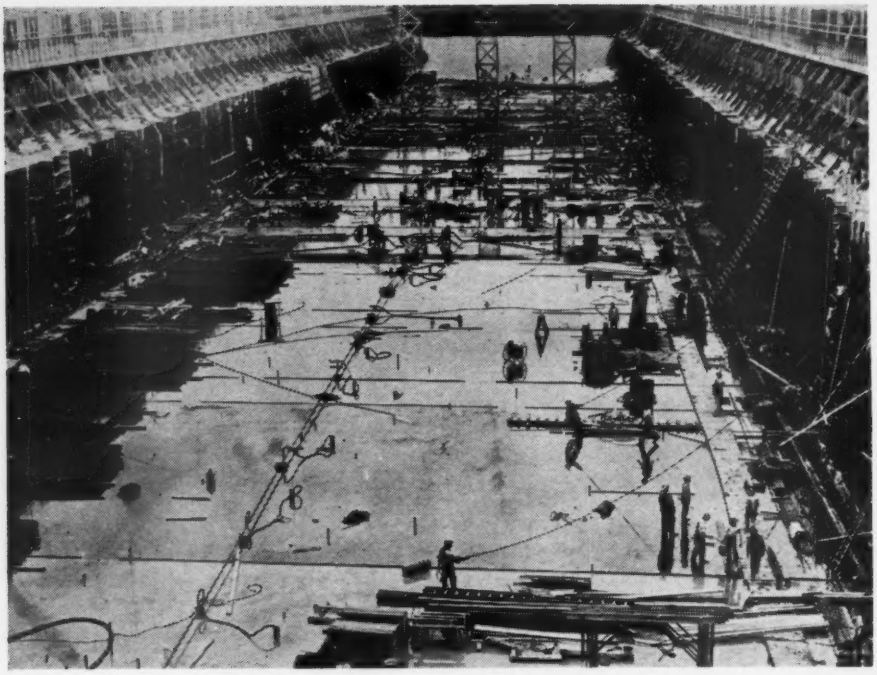
The view above shows a basin excavated at the waterfront and a cofferdam of steel sheet piling surrounding the immediate area in which a dock is to be built. The structure in the center is the steel caisson gate of one of our new docks in process of erection. When in place at the outboard end of the dock the gate will be provided with pumps that will control the water ballast within it so as to either sink the gate to seal the entrance or to give it sufficient buoyancy to float clear of the dock sill. In that position it can be swung to one side, allowing a ship to leave or enter the dock. The other picture shows the concrete walls of a pump well being sunk by the pneumatic caisson method. The pump well carries equipment for flooding or draining a dock, as required.

stations in number, location, and equipment, adequate to support the fleet in a constant state of readiness for war, and for the services of the fleet should war come, cannot be over-emphasized. Developments ashore have not kept pace with the increases in the forces afloat and in the air, and, as a consequence, we have now reached a point where the efficiency of the striking forces afloat and in the air will soon be seriously impaired by the absence of shore facilities needed for the servicing of these forces."

The purpose of this article is to disclose in part what has been done since 1939 in developing a balanced Navy and to deal specifically with the building of certain dry docks for servicing our combatant ships. These graving docks are unusual in their dimensions, and some of them are novel with us in respect to their primary use. The workshops, piers, dry docks, and all other permanent structures at our Navy yards and other naval stations are broadly classified as "Public Works of the Navy." The responsibility for their design, erection, and maintenance rests on the Bureau of Yards and Docks of the Navy Department, of which Rear Admiral Ben Moreell, U.S.N., as Chief of Civil Engineers, is the present head. This is mentioned only to indicate the importance of the undertakings that have been and still are being carried out under the direction of the Civil Engineers Corps of the Navy to provide on land those things that help tremendously towards fitting the fighting fleet for its job.

Ordinarily, a dry dock of the graving type is an enormous masonry-lined hole excavated in the ground on the shore of a deep waterway. Its outer end is provided with a gate or caisson which may be swung clear to admit a vessel and then closed so that the basin can be unwatered and the craft, cradled on blocks, left in the dry for whatever her hull may need below the water line. When repaired or repainted, the basin is flooded, the gate is opened, and the refloated ship is moved from the dry dock. The initial engineering problem is the excavating of the hole, and then, if practicable, its unwatering so that the floor and walls can be built in the dry. Success and the ease with which the work can be done hinge fundamentally upon the nature of the ground. Graving Dry Dock No. 1 at Pearl Harbor, Hawaii, is an outstanding example of the difficulties that have to be mastered; and while the unstable ground dragged the undertaking out over a period of ten years, it not only taught those concerned invaluable lessons but laid the foundation for developments that have made it practicable to construct still larger graving docks with astonishing rapidity despite hampering natural forces.

Geologically, the ground at Pearl Harbor is of recent formation and the result of volcanic eruptions and shattered coral reefs, combined with weathering and the pulverizing pounding of heavy seas. Superficially, the site chosen for the dock was favorable—the ground being firm enough to support heavy concentrated loads; but, all too late, the subsurface formation was found to be porous, semiplastic, and decidedly unstable. The contractor, experienced in dry-dock building on our West Coast where the ground formations are far older than on the Island of Oahu, elected to construct the dock within a timber



NEARING COMPLETION

At the left is a view of a new dry dock at Norfolk, Va., taken shortly after it was unwatered but before the side walls had been extended to their full height. This concrete work, as well as giving the walls a finish facing and pouring the top course of the floor, was done in the dry, whereas all the concrete shown here was placed underwater by tremies. The service gallery of one of the new docks is shown below. It houses pipe lines conveying compressed air, water, and steam for use in either building or repairing ships.

caisson sturdily reinforced internally by heavy cribwork. The plan was to divide the caisson transversely into separate sections about 200 and more feet in width, measured on the longitudinal axis. Each was to be unwatered and the concrete floor and side walls placed in the dry—succeeding sections to be suitably interlocked to form a single, monolithic structure.

When the first cofferdam section was believed ready for unwatering, the pumps were started; but when the level of the water had dropped a moderate extent the cribbing tended to rise, so pumping was halted and the procedure changed. Timber piles were driven into the bottom of the excavated area to serve as an anchorage for a course of concrete 6 or more feet thick enveloping the tops of the piles and forming a seal against further inflow. That concrete was placed with the aid of tremies, but it failed of its purpose because of the composition of the mix and inexperience in pouring concrete underwater. All the defective concrete had to be removed, and while that was being done work proceeded on the second cofferdam section. In its case, piles were also driven, but a seal of richer concrete, a little less than 7 feet thick, was poured with tremies. All told, 8555 cubic yards was placed subaqueously.

Early in 1913—forty months after field operations had started—unwatering of the second section was begun and pumping continued for eleven consecutive days during which the cribbing rose slightly but increasingly. Then, when the water level had been lowered a maximum of 36.75 feet, sections one and two suddenly collapsed as the ground pushed inward and upward like a seismic upheaval, fracturing the concrete and shattering the massive caisson and cribbing timbers. Nature had outwitted the engineer. The hydrostatic uplift on the bottom concrete at the time of the disaster was computed to be approximately 3100 pounds per square foot.

Members of the Civil Engineer Corps of the Navy and civilian experts thereafter spent months scheming how to proceed and to redesign the dry dock for which Congress in 1908 had fixed the limit of cost at $2,000,000. The revised plans were not approved until November, 1914, and construction was not taken in hand until a year or more later because of the nature of the preparatory work. Actually, the collapse of the cofferdam was a blessing in disguise, for if the dry dock had been built in accordance with the original contract it would soon have been inadequate—not commodious enough to accommodate the largest ships on the ways or projected for the Navy.

As first planned, the dock was to have an over-all length of 589 feet; but between then and November of 1914 its dimensions were altered three times. The final specifications called for a structure 1010.5 feet long. Meanwhile, the cost had mounted until the final figure was close to $5,000,000. It will be recalled that the Panama Canal was opened for traffic in 1914 and that its locks were limited in length to approximately 1000 feet, which fixed the size of any ship that could use that man-made waterway. The battlecraft of the U.S. Navy were at the time steadily increasing in displacement, and it was therefore strategically desirable that the Pearl Harbor dry dock should be of a size to take any of our fighting ships that could make the passage of the canal for the purpose of protecting the national interests in either the Atlantic or Pacific. It was self-evident that some radically new method would have to be devised to build at that outpost a graving dock comparable in capacity to the locks of the Isthmian waterway.

Among the members of the naval group that, together with the contractor, sought a solution of the problem was Frederic R. Harris, subsequently Rear Admiral Harris, Chief of the Bureau of Yards and Docks, who was placed on the retired list in 1927. He contributed the original plans by which the construction of the dry dock was carried to a successful conclusion that was marked on August 21, 1919, by the first flooding of the structure. By the changed procedure it was not necessary to unwater anything. The dock was built in sixteen sections in the dry and each was sunk to its prescribed resting place on the bottom of the excavation. Then additional concrete was poured into each, thus completing it and giving it the dead weight that would keep it down, even when pumped out, against the upward force

hydrostatic pressure against the floor of the dock.

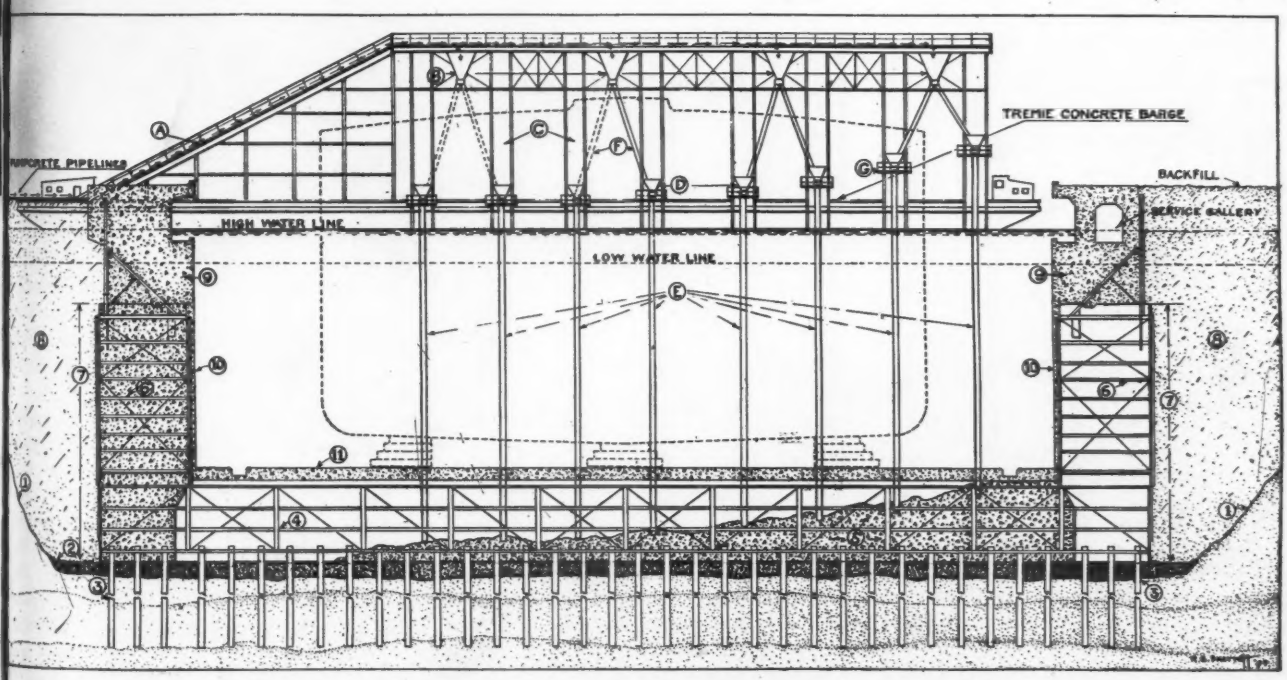
Subsequently, two more graving docks were constructed at Pearl Harbor both of which represented engineering advances. The first was completed in a little more than two years. The second and biggest structure was the work of Frederic R. Harris, Inc., of which Rear Admiral Harris is president. That immense dock was taken in hand coincident with the large increase in the Navy authorized in 1939 and was built within the astonishingly short span of twenty months, actually a year sooner than scheduled! Fortunately it was ready for service two weeks before the Japanese made their treacherous attack and received one of the large damaged ships of the Pacific fleet two days after that raid.

While the last-mentioned structure was underway, the Bureau of Yards and Docks, under the direction of Rear Admiral Ben Moreell, as Chief of Civil Engineers, was pushing construction on numerous other dry docks on both our Atlantic and Pacific coasts, locating them where they would be of the greatest use, regardless of ground conditions. In this article we will deal only with some of the docks that are primarily designed as building sites for the most powerful capital ships authorized latterly for our battle fleet—in other words, only with those that can be utilized for conventional dry-docking operations when they are not occupied by vessels in process of construction. These docks are on the eastern seaboard—at the Norfolk, Philadelphia, and New York navy yards.

Wide-awake citizens may wonder why graving docks should be provided especially for shipbuilding purposes when it has long been the practice to construct vessels on shipways on shore and to launch them when work on their hulls was suitably advanced. The answer is that the big new structures, although costing millions of dollars each, not only will save money and time but are also adaptable—not limited, as is a shipway. Capt. J. J. Manning, Civil Engineer Corps, U.S.N., thus explains some of the reasons for them: "The shipbuilding ways built during the last war for battleship construction were not of adequate size to accommodate the ships now projected, nor was the basis of design adaptable to present work. The heaviest weights used in hull construction in bygone days were applied after launching; present designs require the placing of these weights before launching. Likewise, the weight concentrations have been moved from the center line to the exterior of the ship, requiring almost a complete rebuilding of shipways to accommodate the new load distributions. This feature means that the weights of ships at launching are far in excess of any heretofore experienced."

Where shipways have been strengthened and facilities added for handling the greatly increased loads, the outlays have been very large and the modified ways have not contributed measurably to the speedier construction of the vessels. Finally, the launching of a large ship entails grave risks—in transferring such an immense body from the land to the water it may be seriously impaired structurally. The history of the shipbuilding industry contains many records of such mishaps, and even of disasters.

In a dry dock designed for ship construction the biggest battleship can be built from her keel plates upward; all her machinery can be lowered into the hull by hammerbead cranes that can handle unit weights of as much as 350 tons; and the main batteries of 16-inch guns, their ponderous turrets, and the lesser batteries can be put aboard while the craft is still under construction. Then, when everything is ready, the dock can be filled with water, permitting the ship to float free from the keel blocks on which she has rested from the beginning. No hazard is involved in the transfer. Today, the weights handled during building call for lifts to lesser heights than former-

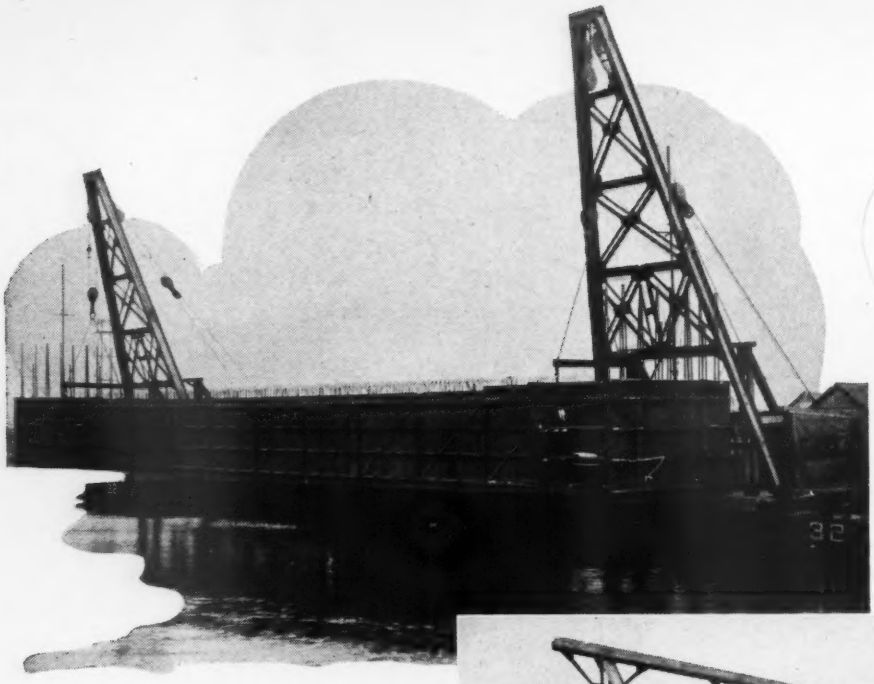


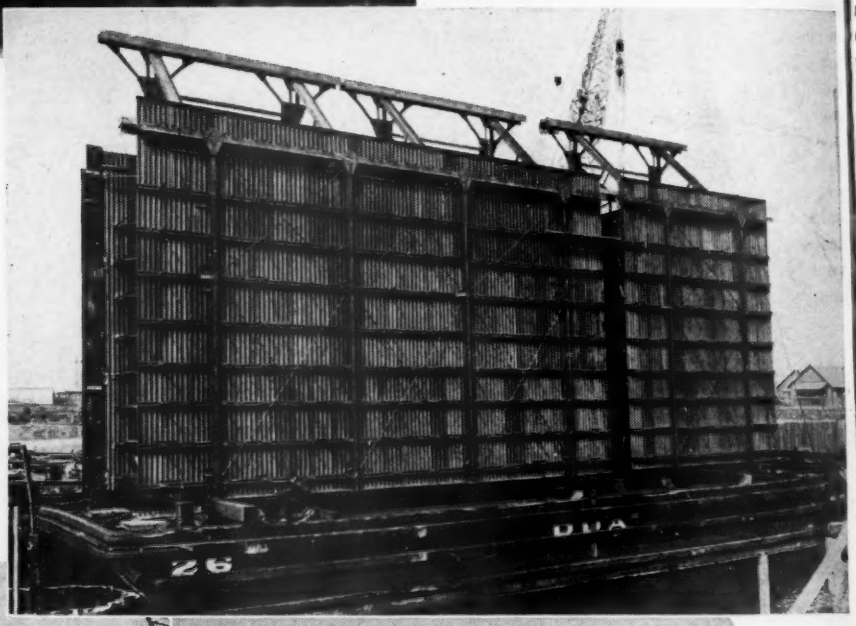
HOW OUR NEW TYPE OF DRY DOCKS ARE BUILT

1–Side slopes of the original excavation. 2–Bed of crushed stone laid on the bottom and carefully leveled. 3–Steel H-beam piles driven through the rock blanket and deep into the underlying ground to serve as an anchorage against vertical movement of the massive side walls and floor slab of the dock when it is unwatered and lightened. 4–Steelwork of a form for the tremie-poured section of the floor slab. 5–Tremie-placed concrete during the filling of a floor-form section. 6–Opposite side-wall forms in which tremie concrete is poured simultaneously. 7–Height to which walls are placed by tremie. 8–Excavated areas on sides of dock that are backfilled progressively as the walls rise. 9 and 10–Sections of the concrete side walls that are poured in the dry. 11–Top course of the floor slab which is placed in the dry after the dock is unwatered for the first time. *A*– Ramp on barge carrying pipe lines for transmitting tremie concrete from a central mixing plant on shore to the main hoppers on the barge; *B*–main concrete hoppers; *C*–Insley towers; *D*–tremie hoppers; *E*–tremie pipes; *F*–elephant-trunk spouts that deliver concrete from the main hoppers to the tremie hoppers; *G*–elevator platforms that travel up and down on the Insley towers.

ly and the work can be done quicker and at a reduced outlay because much of it is merely lowering so that the expenditure of power is correspondingly cut down.

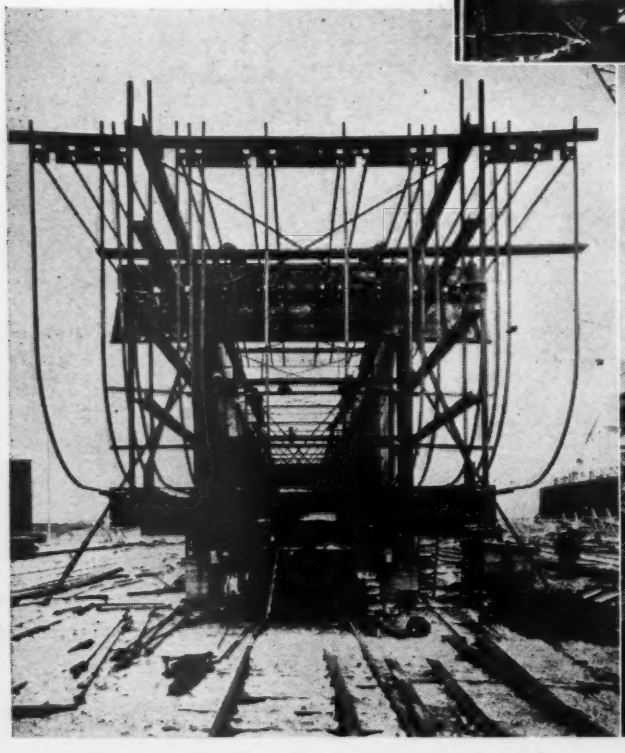
At some of the naval stations the ground conditions have made it possible to build docks in the dry by simply surrounding the areas with cofferdams and then unwatering them. But the most novel method of construction is that where foundation conditions are such that the dock site cannot be unwatered, as was the case at Norfolk, Philadelphia, and New York. There the major part of the concrete had to be placed subaqueously with tremies. The two new docks at Philadelphia lie side by side close to the waterfront and with their center lines 440 feet apart—the intervening strip affording a common way for the large cranes and cars used in handling

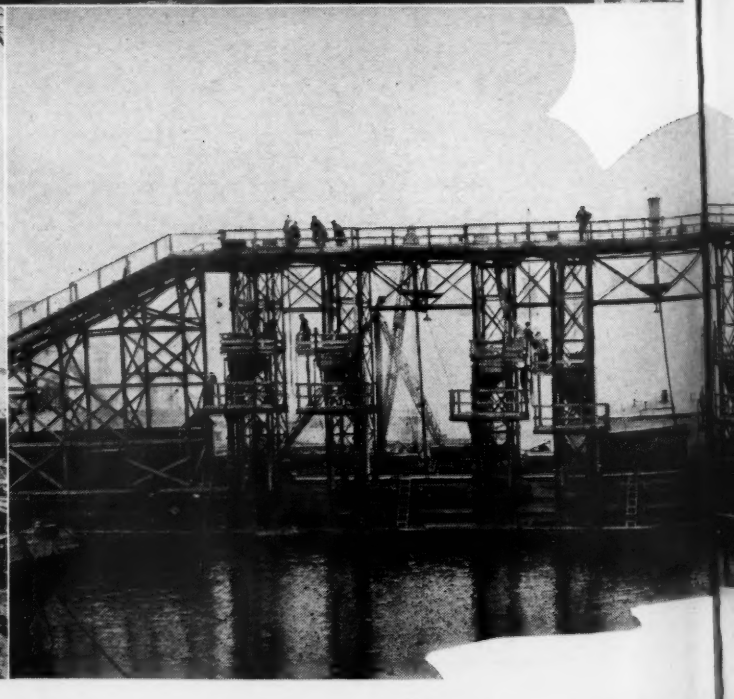




FORMS FOR CONCRETING UNDERWATER

At the right is seen a wall form in process of erection. After serving to confine the concrete placed by tremie, the steelwork becomes reinforcing for the deposited mass. The picture below shows the assembling of a steel form for a unit section of the thick bottom slab of a dock. Here, again, the steel is embedded in the concrete. A completed form for use in pouring the bottom slab is illustrated at the top. These forms extend across the full width of the dock and are placed parallel to one another, with intervening spaces suitably braced serving as forms.





and transporting materials for ships underway. The excavation for each dock had a bottom width of 216 feet, a top width of 436 feet, and was dredged to a depth of 53 feet at low water. To steady the outlying ground, both sides and the inner end of each basin was surrounded by bulkheading formed of interlocking steel sheet piling.

With dredging completed, a blanket of crushed stone was spread on the bottom of each dock site and leveled off to a minimum thickness of 2 feet with a drag made of I-beams. Down through this layer were driven rows of steel piles consisting of H-beams each 60 feet long and weighing nearly 3500 pounds. These were spaced across the excavation at 5-foot intervals and about 6 feet apart longitudinally, passing through a stratum of soft material and extending well into firm ground. When seated to the prescribed depth, the upper ends rose approximately 3 feet above the surface of the crushed stone. A total of 6825 piles was driven in the bottom of each basin and provides an anchorage for the massive reinforced-concrete floor slab that has a finished thickness of 16½ feet. In the final course of 2½ feet, which was poured after the dock had been unwatered, are the inserts for the many hundreds of keel blocks that can be adjusted laterally to take the weight of a ship unsupported by water.

Each of the twin docks has an effective length of 1100 feet, is 150 feet wide, and the entrance sill lies 33.8 feet below water level at low tide. The side walls, also of reinforced concrete, are interlocked and tied by reinforcing to the floor slab. They are 15 feet thick to a point 44 feet from the bottom, extending thence to the ground surface in modified form. Up to about mean tide level the walls were poured by tremies and involved the handling of approximately 500,000 cubic yards of concrete.

All concrete in the floor slab and side walls placed by the tremie method was deposited in steel forms that became embedded and so served as permanent reinforcing. These forms were assembled on shore and loaded on large car floats from which they could be lowered on to the piles with a precision that permitted only a small tolerance. Each floor form was as long as the dock was wide, was 14 feet high, 12 feet in breadth, and could be picked up at two points by shear legs for lowering—their positions being checked by cross bearings established at the sides of the basin.

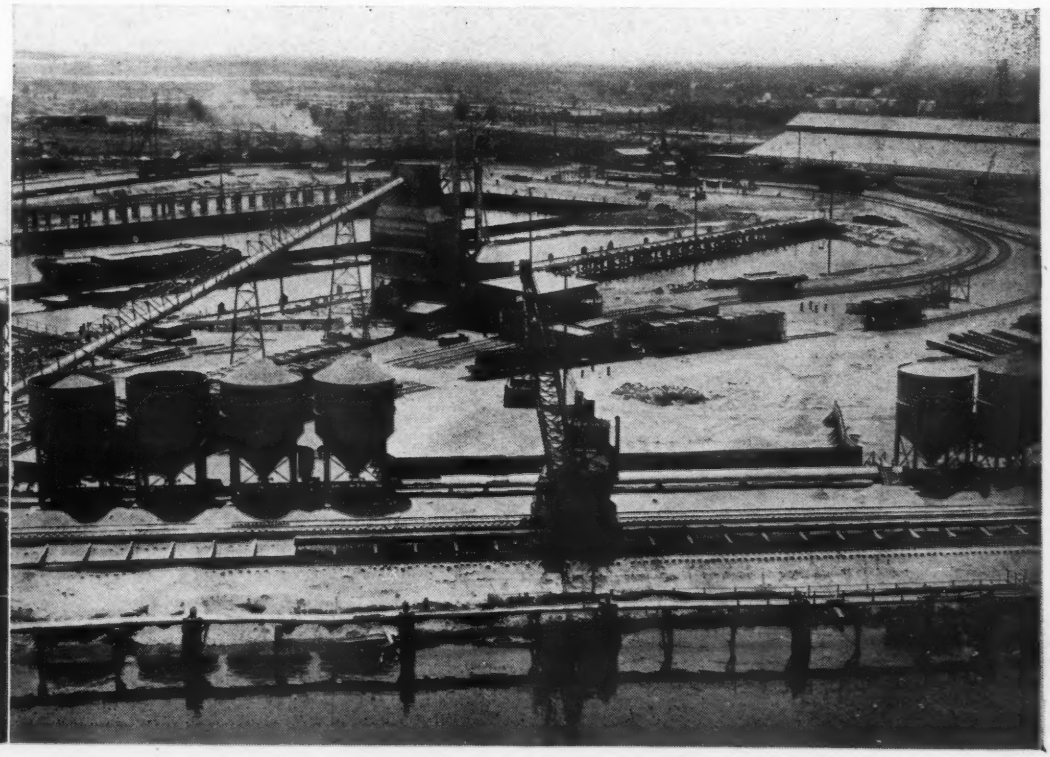
With a floor form correctly located, the next step was to fill it by tremie in one continuous operation involving the placing of 1000 cubic yards of concrete in an 8-hour shift. Forms were used only for alternate sections of the floor slab—the poured ones functioning as forms for the intermediate sections, which were reinforced by steel connecting the flanking forms and the adjoining side-wall forms. The latter were 15 feet wide, 36 feet long, and 44 feet high, and each called for the tremie placing of 850 cubic yards of concrete. It was possible to pour wall sections at an average rate of 60 cubic yards an hour with only one machine. Three were used in placing the floor slab.

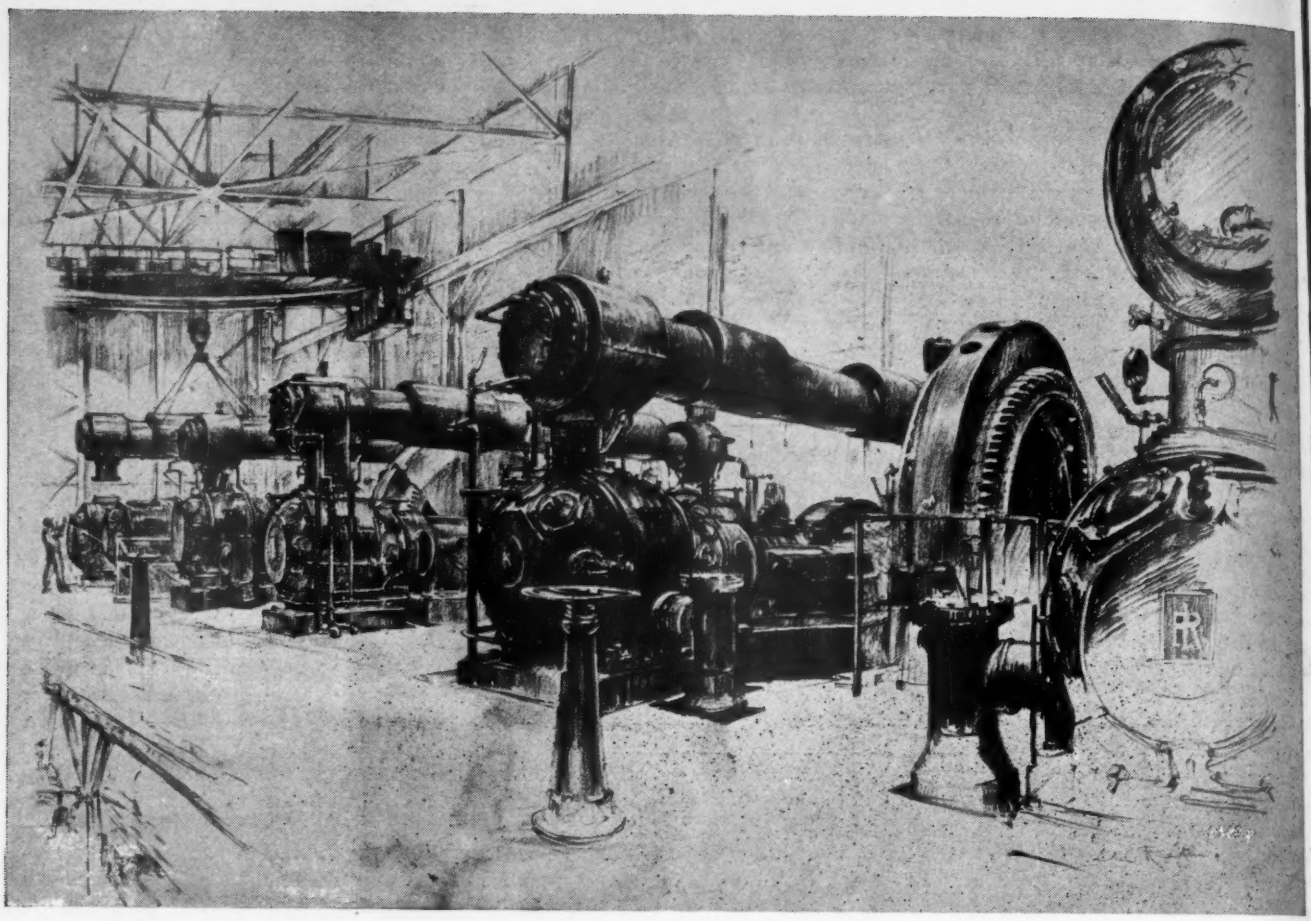
The concrete was mixed in a central plant and transmitted the equivalent of a horizontal distance of 1450 feet through 8-inch pipe lines that discharged into hoppers on ingeniously arranged barges. Each of these mounted eight Insley towers equipped with sliding frames, and each frame carried a 3-yard hopper feeding a 12-inch tremie pipe made up of flanged sections and having a maximum length of 60 feet so as to reach to the bottom of a dry-dock basin. A smaller type of barge with but two tremie pipe lines served for pouring the side walls.

Placing concrete by the tremie method, while simple in principle, is often fraught with difficulties in practice, and the deposited material may be woefully lacking in uniformity and strength. This is due to what is termed "loss of seal"—that is, the washing action of the surrounding water induced by the reflexes incident to the use of a tremie. When descending in a tremie, concrete pushes be-

CONCRETE PLANT

In building our new docks, the concrete is prepared in a central mixing plant such as that shown at the bottom, right. From there it is pumped to tremie-concrete barges that place it in the underwater bottom-slab and side-wall forms. The same plant supplies the concrete required later for the upper sections of the walls and finishing courses, which are placed in the dry. In the center, below, is shown a barge equipped with eight Insley towers, elevator platforms, and hoppers feeding into tremie pipes that deliver the concrete to the exact pouring positions underwater. The tremies are made up of flanged sections having a maximum length of 60 feet.





A DRY-DOCK COMPRESSOR PLANT

A drawing, by Miss Lili Rethi, of the permanent compressor plant that furnishes air for building or repairing ships at the New York Navy Yard's new dry docks. These Ingersoll-Rand machines are of the 4-corner type, so-called because there is a compression cylinder at each corner of the rectangular unit formed by using two parallel frames, with the synchronous driving motor mounted centrally between them. Each compressor has a capacity of 10,280 cubic feet of air per minute. This picture is reproduced by permission of the U. S. Bureau of Yards and Docks.

fore it any water in the pipe, thus setting up a strong jetting movement. As a result, the previously poured material is forcibly swept by that water, and the binding grout is washed away from the surface. Conversely, when the last of the concrete has issued from the tremie, then there is an inrush of water, and again strong movement tends to impair the fresh concrete and to promote weakening segregation of the mix. Hence, the loss of seal entails, according to the specifications of the Bureau of Yards and Docks, the removal of all concrete in a pour.

The contractor minimized the likelihood of loss of seal by devising the "valve tremie process." He interposed a 12-inch plug-cock valve at a point in the pipe approximately 35 feet above the lower end, and directly below the valve made a connection for an air hose. Both the compressed-air supply and the valve could be controlled by the operator stationed on the platform of the sliding frame of the tremie unit. In making ready for a pour, the platform was raised until the valve, in the closed position, was just above the surface of the water. From the valve on up to the hopper, the tremie was then filled with concrete. Next, compressed air was admitted to expel any water in the pipe below the valve, virtually converting that end into a diving bell. In that condition the tremie was lowered to within an inch of the water bed so that the confined air could escape without developing objectionable back pressure when the plug cock was opened and the concrete was discharged into a form. With the flow started in this manner, and with the hopper maintaining a continuous supply, it was possible to prevent loss of seal. Success was further assured by the watchful services of divers whose job it was properly to place the discharge ends of the tremies and to inform the men on the operating platforms when to begin each stage of their work.

When the first of the Philadelphia dry docks was well advanced, a temporary cofferdam was erected 860 feet out from the head or inner end, and in that space was started the after and midship sections of a large ship. Subsequently, a cofferdam was reared around the outer end, and in that temporary enclosure was constructed the caisson gate by means of which a dry dock is closed so that it can be unwatered. Immense as these new structures are, any one of them can be unwatered in two hours by the three big 54-inch centrifugal pumps provided for that service.

The docks were taken in hand successively, and work on the second one was speeded up by applying lessons learned while the first was underway. Operations were carried forward continuously night and day, and compressed air was used for many purposes and in large volumes. Later, the docks were provided with a compressor plant to supply the air needed in building or repairing big battlecraft. Each was completed in about two years, and when finished and fully equipped cost around $10,000,000.

The contracting organization, known as Drydock Associates, was a combination of well-known engineering and construction firms—Spencer, White & Prentis, Inc.; Foley Brothers, Inc.; and Merritt-Chapman & Scott Corporation, with Frederic R. Harris, Inc., collaborating as consultant. The latter was identified with the designing and building of a similar dock at Norfolk where construction proceeded substantially as at Philadelphia, and contemporaneously.

The two naval dry docks at New York are of the same dimensions as those described and were built in what may be designated as "made ground" that presented difficulties. Most of the structural work had to be done subaqueously, and neither dock could be unwatered until the floor slab was in place and the side walls had been reared well-nigh to mean tide level. Divers, extensively employed on the job, were greatly hampered in their labors because artificial illumination was impracticable and they had to rely largely upon their sense of touch and occasionally upon the very restricted glow of the tips of metal-cutting torches.

The New York twin dry docks were constructed simultaneously and necessitated the dredging of 2,300,000 cubic yards of sandy silt to a depth of approximately 63 feet below mean low water, except in a small area that was excavated an additional 9 feet. With dredging completed, bearing piles were driven in the bottom of the basin after it had been leveled with I-beam drags and covered with crushed stone to a fairly uniform thickness of 2 feet. The piles are 12x12-inch H-beam sections weighing 74 pounds per linear foot and ranged in length from 30 to 70 feet, depending upon the condition of the ground, which varied to a marked extent. Excess lengths were burned off with subaqueous gas torches; and the top of each pile, which cleared the water bed 3 feet, was embedded in the lowermost course of the floor slab and side walls. So interlocked with the concrete, the piles serve the double purpose of a foundation support and an anchorage that will resist the upward hydrostatic thrust of the water-bearing ground when either dock is lightened by unwatering. The H-beams were spaced generally 5x7 feet apart and each was precisely positioned through a telescopic lead on the pile-driving barge, which was held by quartering cables to prevent any shifting because of wind or tidal action. If there was any doubt as to the position of a pile after it had been driven, any error was determined by a line plumbed between its head and the barge, the services of a diver being required to secure the line to the pile.

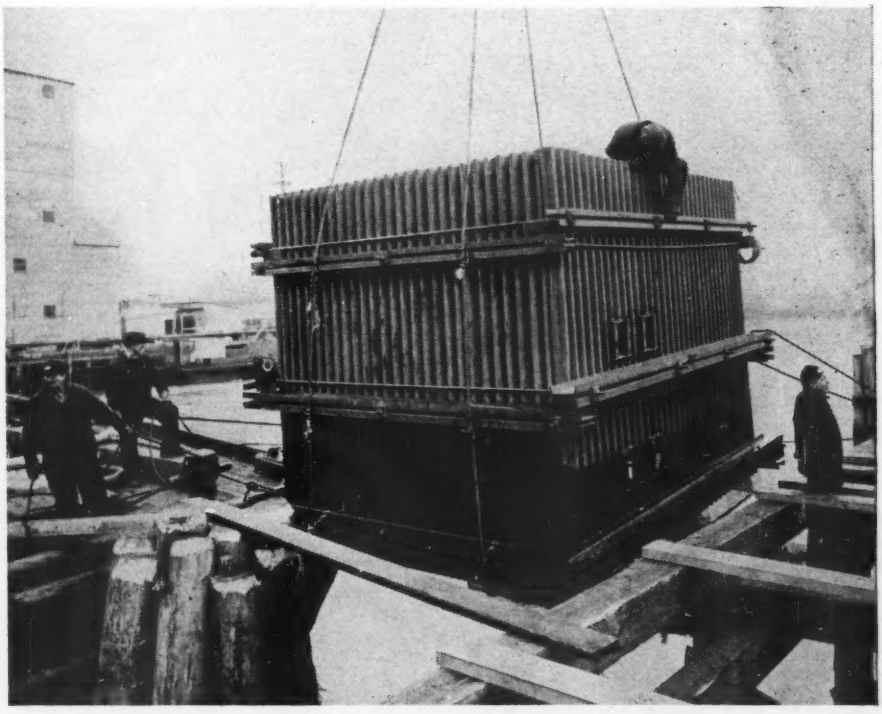
The floor-section and the side-wall forms varied only in some minor particulars from those already described. They were assembled on shore and placed in substantially the same manner, and tremies were utilized to pour the underwater concrete. To prevent loss of seal, the contractor used a canvas-covered plywood disk, 1-inch thick, that fit snugly in each 12-inch tremie pipe. This disk was inserted in the top end and held in place by a running line that could be released when the plug reached the outlet so as to allow it to float to the surface.

As a charge of concrete was built up in the pipe by the supply hopper, the disk descended progressively until the tremie held a column 30 feet high—ample to form a temporary seal at the outlet while a steady stream of concrete continued to flow into and out of the pipe. This was maintained until a given section of the floor or side-wall form had been filled high enough or laterally far enough to surround the next nearest tremie, which then began pouring. In this way the accumulating concrete shoved the bottom silt before it and to one end of the form, thus preventing it from intermixing and impairing the ultimate strength of the concrete. The latter had a slump of about 8 inches to assure its spreading steadily around the supporting piles and the steelwork. The silt or mud was cleared away by air lifts controlled by divers, who had many things to do in coördinating the manifold operations and were equipped for the purpose with 2-way telephone sets installed in their helmets. The lifts ranged in diameter from 6 to 12 inches and raised the material a maximum distance of 80 feet to the surface, some of them handling a volume of as much as 2000 gpm. This work naturally entailed the use of a great deal of compressed air.

A temporary cofferdam was next erected across the entrance of each dock, and this permitted unwatering the latter and making it available for service before the completion of the outboard end and its closure with the caisson gate. Preparatory to starting concreting on the inboard section, the contractor had to remove from the exposed side walls and floor heavy deposits of silt and mud that had settled there during the construction period. Air lifts were also of great aid in this work and were effective even when the water was only 18 inches deep and the lift totaled 70 feet. Final cleaning was done with hose discharging a mixture of water and compressed air—the air, through its expansive and agitating action, substantially helping the strong streams of water to sweep away the most resistant films of silt.

All concrete was mixed in a central plant and delivered by pipe lines from a pumping station equipped with eight Rex Pumpcrete units. These transmitted the material a maximum horizontal distance of about 1100 feet or, with allowance for bends and rises, the equivalent of 1600 feet. The installation was of sufficient capacity to deliver to the floating tremie barges as much as 350 cubic yards of concrete per hour.

Drydock Engineers developed the design for the New York twin dry docks and was composed of experts of the firms of Parsons, Klapp, Brinckerhoff & Douglas; Moran, Proctor, Freeman & Mueser; Frederic R. Harris, Inc.; and Fay, Spofford & Thorndike. The construction work was done by Contractors for Drydocks made up of the well-known firms of Walsh Construction Company; J. Rich Steers, Inc.; Cauldwell-Wingate Company; and the Raisler Corporation. Rear Admiral Ben Moreell, as Chief of the Bureau of Yards and Docks, was represented on all the jobs by officers of the Civil Engineer Corps of the Navy.



CONCRETE TEST FORM

This form was used for pouring a test block of concrete by the tremie method on the crushed-stone foundation for a new dry dock. The block was afterward raised, drilled, and blasted to determine the soundness of the concrete.

Echoes of Western Railroad Construction

Highlights of Two Eras in Building the Western Pacific, Last of the Great Mountain Systems

Lawrence A. Luther

ALONG THE LINE

At the top, a 6000-hp., 4-unit diesel-electric locomotive is shown hauling freight through the canyon of the Feather River in California. In the center view is pictured a track gang using sixteen pneumatic tie tampers to surface the roadbed near Oroville, Calif. A connection between the Great Northern and Western Pacific systems is made at Keddie, Calif., by means of a wye that is typical of heavy mountain construction. At the left are seen two branches of the wye on high steel trestles. The third is in a rock tunnel.

THE renowned Mormon leader Brigham Young suffered a great disappointment in the later years of his life, and that was his failure to put a kink in the first transcontinental railroad so that it might pass directly through his beautifully geometric capital city on the shore of Great Salt Lake, Utah. With the completion of the surveys on the Central Pacific and the Union Pacific, extending from San Francisco, Calif., to Omaha, Nebr., he came to recognize the impracticability of a detour through the Wasatch Range to put Salt Lake City on the main line. His Latter Day Saints hewed thousands of crossties and gave invaluable assistance in grading the competing railroads during their home-stretch race to the junction at Promontory Point, Utah. Yet there was to remain the cherished dream of a railway that would come right to Salt Lake City and go straightaway westward to the Pacific Coast. Could Young have lived about a quarter century longer he almost certainly would have made George Gould a fellow conspirator in his plan for such a transcontinental system, because the line that reached terminus at Salt Lake City in 1883, and that is now The Denver & Rio Grande Western, had become a lusty young mountain road and a dividend payer by 1901 when Gould bought in to secure controlling interest.

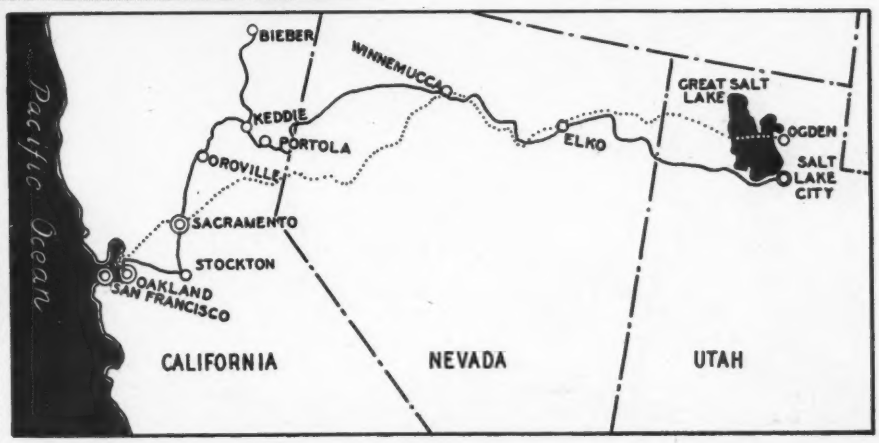
When word got around that Gould proposed constructing a railroad from Salt Lake City to San Francisco Bay, there were already in existence five transcontinental lines. The new railway was to be called the Western Pacific, and the route tentatively chosen started west from the Mormon capital and skirted the south end of Great Salt Lake, by coincidence going along the Hastings Cutoff taken by the wagon train of the ill-starred Donner party, which typifies the worst aspects of early transcontinental travel. It consisted of a group of 87 that had left a westward-trekking caravan on July 20, 1846, at South Pass in what is now Wyoming. In seeking the short route, the migrants lost their race against winter in hewing a trail through the canyons of the Wasatch Range. By the time they reached the Sierra Nevadas, and a party from John Sutter's adobe fort at Sacramento had come to their aid, the bitter cold and snows had taken a toll of 40 members. A monument stands on the shore of Donner Lake in memory of those valiant pioneers.

In California, the Western Pacific builders proposed to invade the Sierra Canyon of the Feather River and to follow the trails of the long-departed Forty-niners who had laboriously sifted virtually every spoonful of the waterway's great gravel beds. Work on the location of a satisfactory Sierra crossing, which was the most crucial problem, was begun in 1902 when President Jeffery of The Denver & Rio Grande sent Henry H. Yard on a reconnaissance. Theodore D. Judah, celebrated locator of the Central Pacific, had explored the Feather River route some 35 years earlier and had reported that it would require excessive expenditures and too long a construction period, no doubt by reason of the earth-and-rock handling equipment available in the 1860's. Other studies of the canyon as a rail line had been made for interested parties—one by William Storey, who later became president of the Santa Fe.

The great Sierra canyons of the Yuba, the American, and the Rio de Los Plumas are as strikingly different as though each had been conceived and carved out by an individual deity. The Feather is the third-longest river in California. While its canyons are among the most rugged, it provides a gateway through the crest of the Sierra at an altitude of approximately 5000 feet, something more than 2000 feet below the Donner Summit elevation reached by the Central Pacific. Two companies were created by Yard, the locating engineer, to make surveys and to obtain rights of way. His project clashed with similar enterprises promoted by a Mr. Bartnett and on which Arthur W. Keddie, a pioneer mountain surveyor, had been retained as chief engineer. The conflicting claims were settled by compromise, and Keddie's flair for topography and his familiarity with the entire region proved invaluable throughout this period. As was to be expected, the acquiring of the rights of way interposed barriers, for few enterprises seem to have resulted in so many dramatic clashes of interest as railway building. As late as January 6, 1909, when the Western

LOCATION MAP

The Western Pacific is indicated by a solid line and the older Southern Pacific, formerly the Central Pacific, by a dotted line. The Western Pacific main line from Salt Lake City to the coast was built between 1905 and 1909. The section between Keddie and Bieber to connect with the Great Northern was constructed in 1930-31.



Pacific was well towards completion, the *San Francisco Chronicle* carried a headline, "Open War on the Waterfront," in describing the drive to establish the line through contested territory.

A company was incorporated under California laws in 1903, and by 1905 it had been determined that a satisfactory route could be established. There was the usual alluring uncertainty as to which mountain towns were to find themselves on a main-line railroad. One editorial admonished the locators to choose wisely, with the necessity of the highly competitive haul in mind, and not to forget that the great canal through the Isthmus of Panama was abuilding. Then it very modestly pointed out the obvious advantages of the home-town route. In the matter of capital, a trust agreement was made in June of 1905 by which The Denver & Rio Grande guaranteed the interest on the first mortgage bonds, thus assuming a paternal relationship to the new line and a grave financial responsibility.

A significant clause in the agreement stipulated that a maximum grade of 1 percent, compensated (very low for a mountain road), and a maximum curvature of 10° were not to be exceeded on the entire system. To adhere to those standards and to cross the Sierra at an elevation of 5018 feet, it was necessary to drive 44 tunnels, 8.7 miles long, which proved to be the most difficult and delaying phase of the whole undertaking. These passageways varied in length from 160 to 7335 feet, and their excavating through hard rock was, in some cases, complicated by varying mishaps such as the tapping of a sizable underground stream in the longest of them, the Spring Garden Tunnel. In order to maintain the grade at one point in the Sierra, a 4680-foot loop had to be built, and another of similar size was required in negotiating a range in Nevada.

Very little of the canyon was at that time accessible, and the job of building access roads was a sizable one in itself. Recruiting and retaining labor to serve at remote camps often proved difficult. No inexhaustible army of Chinese coolies at $35 per month without board was available, as in the days of the Central Pacific. On the other hand, the work was not hampered by vast, paralyzing snowfalls and by the intensely cold weather at higher altitudes. It is claimed that in the winter of 1866-67, forty-four storms deposited 40 feet of snow on the Central Pacific at Donner Summit. Huge timber snowsheds, with a total length of 37 miles, were built in order to keep the line open, and as many as 2500 men were employed on that job. A large part of those sheds has been removed by the Southern Pacific Company, which now operates the Central Pacific, because stronger roadway construction and modern snow-fighting equipment have made that practicable. On the Western Pacific there are no protecting snowsheds, only two great rotary snowplows, one of which is kept at Portola and the other at Keddie.

As planned, the Western Pacific had a length of 927 miles. With the exception of the stretch from Salt Lake City to Oroville, including the canyon crossing, the work was allocated to several divisional organizations and was carried on simultaneously at many points. The contract for the first-mentioned section was let to the Utah Construction Company, with the brothers W. H. and E. O. Wattis actively in charge, and involved the excavating of the following materials:

15,000,000 cu. yds.	common	$0.19 per yd.
8,000,000 " "	loose rock	0.45 " "
14,000,000 " "	solid rock	0.90 " "

Actual work on the road was begun in 1905 and completed in the fall of 1909 at a cost of $79,000,000. It is interesting to note that the present chief engineer of the line, T. L. Phillips, and other past and present members of the Western Pacific staff, played parts in its construction.

Southern Pacific News Bureau Photos

BUILDING OF THE CENTRAL PACIFIC

In striking contrast to modern methods, all rock was drilled by hand (left) and both rock and earth were hand loaded into 1-horse dump carts for disposal. Most of the labor was Chinese. To make room for more workers, excavations were divided into benches at several levels, as shown in the picture above.

EMERGENCY CONSTRUCTION

Railroads use portable air compressors mostly to furnish motive power for track-maintenance tools, but the machines also serve the lines in many other ways. Recently two portable units were rushed to a location in the Feather River Canyon to supply air for operating rock drills required in building a "shoofly" around a burned-out tunnel.

By 1926 the line had come under the financial control of Arthur Curtis James, whose beard, yachting prowess, and ever youthful zest for doing big things helped to embellish his colorful role as the last of the old-school railway giants. He liked to feel a certain kinship in purpose with James J. Hill. Under the former's aegis, a road was built in 1930-31 to connect the Western Pacific with the Great Northern at Bieber, Calif. This extension gives access to the Klamath Falls area and joins the main line at Keddie in the Sierra Canyon. The wye by which this junction is effected is unique and typifies the heavy construction of the Bieber extension. Two of its legs are carried across the canyon on high steel trestles while the third is in a hard-rock tunnel. The contract for the work was let jointly to the Utah Construction Company and the W. A. Bechtel Company. In spite of the ruggedness of the region traversed, the job was completed in the remarkably brief span of sixteen months, seven ahead of schedule.

When the extension was ready for service in 1931, only 63 years had elapsed since the original Central Pacific crossing of the Sierra. The earth- and the rock-handling equipment employed on the respective projects illustrate strikingly the evolution machinery of this type had undergone in the meantime. It took a year to sink a 1659-foot shaft so that the Donner Summit Tunnel on the Central Pacific might be driven from four faces, and another year to do the tunneling. Chinese labor on the job drilled with doublejack hammers, with steels held and rotated by hand. It is reported of this bore that 7 to 8 inches per day was considered a good day's work. The rock was hard, so hard in fact that, with the shallow hand-drilled holes and low rate of expansion of the black powder used, loads often blew out of the holes "like a charge from a gun barrel," leaving the rock intact. A chemist was recruited to produce a sort of home-brewed nitroglycerine. But this tended to run out of the drill holes, and its instability perhaps accounted for the numerous accidents in which evidence as to cause, as well as witnesses, was often destroyed.

The slow progress made in tunnel driving elicited criticism from the "Big Four" builders of the Central Pacific, for the competing Union Pacific crews pushing westward seemed in a fair way to make good their boast of meeting the Central at the California-Nevada line. Stanford, one of the Big Four, loved things mechanical, and when he was approached by the inventor of a steam drilling machine, he believed it to be the solution of their problem. But the men responsible for the field work had their own conception of how tunnels should be driven, and this did not include steam drills. Even Stanford's digging up an extra boiler to supply steam failed to win them over, and the machine remained untried. No steam shovel was employed on that epochal job; not even the crudest kind of a horse-drawn scraper was used in grading between San Francisco and Carlin, Nev. All earth and rock was hand-loaded into 1-horse dump carts; and cut excavation was done by the bench method so that the Chinamen might work in large numbers, antlike. The equipment utilized was so puny and the undertaking of so great a magnitude, that its accomplishment, viewed in the light of present-day methods, excites wonder and admiration.

By 1905, when the Western Pacific main line was started, man had become less of a pygmy in relation to rock. Good steam shovels were available, and serviceable railway dump cars. Rock was excavated with column-mounted air drills in which the steel moved with the piston and was secured rigidly thereto, for J. George Leyner was just perfecting his hammer drill in which the piston strikes on the drill steel instead of with it. But draft animals, scrapers, and wagons were still relied upon for much of the work; and explosives, although greatly improved, were still in a more or less developmental stage. The same applied to the techniques of drilling, loading, and firing. Today, the old F-24 drifters used on that project appear excessively heavy, crude, and hard to maintain.

By 1930, when the Western Pacific extension was begun, highly efficient drifters, Jackhamers, and wagon drills were available; and large jumbos—portable steel frames mounting many drills—were being used at tunnel headings so that entire rounds could be drilled simultaneously. Rock breakage could be controlled by the depth and angle of holes, the amount of the charge, and the sequence of firing. The steam shovel had changed into a power shovel that was much more responsive than its prototype and was powered by a gasoline or diesel engine. The caterpillar tractor, with a brood of bulldozer blades and huge pneumatic-tired carryalls, had made its appearance. Motor trucks had grown large and were no longer a curiosity. The men most prominent on that job were H. J. Lawler and the late W. A. Bechtel. They represented a new dynasty of giants—men who had mastered the art of handling large volumes of earth and rock and who, along with other contractors, were even then sharpening their mental teeth to tackle the first of a series of huge dams—Boulder

Canyon Dam on the Colorado River.

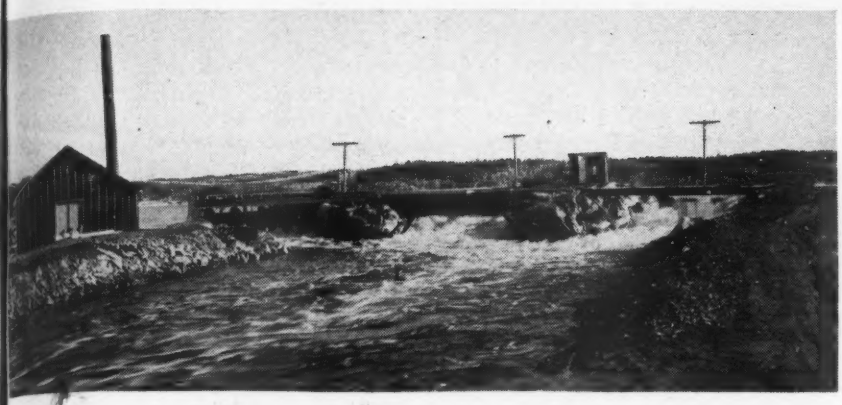
Just a decade after the completion of the Western Pacific-Great Northern connection, the United States Government, in collaboration with the engineering staff of the Southern Pacific Company, built 30 miles of new railway in the lower Sacramento Canyon to take the place of trackage that has since been inundated by the lake formed above Shasta Dam. This doubtless is the finest piece of mountain railroad in the country. While it involved some niceties in construction in the matter of cuts and fills, it is interesting to note that the equipment used was substantially the same as that on the Bieber extension, varying in size rather than in type.

The Western Pacific, like all other transcontinental lines, is handling an unprecedented volume of wartime business and is of far greater military value today than it was during World War I. The road has long utilized many locomotives of the largest Mallet type and recently purchased diesel-electric power that is finding favor with American railways. It has nineteen diesel-electric switchers at its principal freight terminals, and operates six 4-unit 6000-hp. freight locomotives. Its main locomotive and car repair shops are located at Sacramento, and there a diversity of air-driven tools and equipment helps to keep the rolling stock in service condition.

The general improvement program initiated soon after the James interests had acquired control of the Western Pacific was carried on at a cost of some $8,000,000 until it was halted by the depression in 1931. It was resumed and carried forward during 1936, 1937, and 1938 with expenditures of more than $11,000,000, exclusive of those for new cars and locomotives. The laying of heavier rail and extensive reballasting work provided opportunities for the wide use of pneumatic tie tampers and other track as well as bridge tools, Jackhamers, paving breakers, pneumatic woodborers, wrenches, etc. Under present conditions of extreme manpower shortage, equipment of this type is playing an important part in keeping Victory Trains rolling over the nation's railroads, which have been aptly termed "the greatest assembly line in the world."

MAINTENANCE WITH AIR TOOLS

Air-driven tools of many kinds help to keep a railroad running and are of especial importance in these days of manpower shortage. These pictures from the Western Pacific show: Top- a track gang using spike drivers and a joint-bolt wrench operated by air from a 250-cfm. compressor. Center- a section crew equipped with tie tampers supplied with air by a DR60 compressor. Bottom- Another DR60 compressor furnishing air for operating a woodborer during the repair of a freight ferry pier.



Pumping 2,000,000 Tons of Water a Day

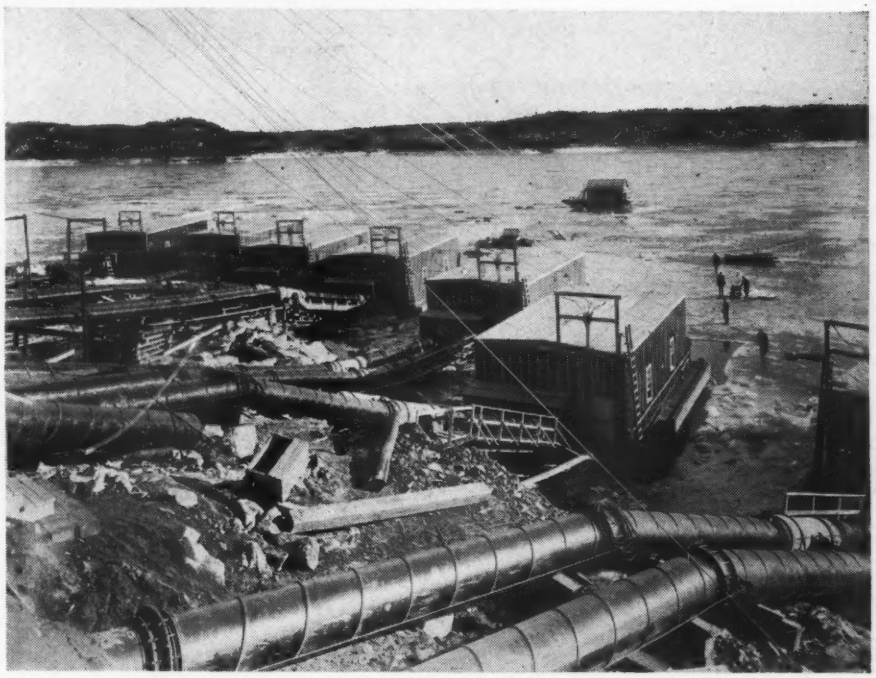
C. H. Vivian

FOURTEEN large-size centrifugal pumps are at work unwatering Steep Rock Lake in northwestern Ontario, Canada, to expose submerged deposits of high-grade iron ore for mining. Every 24 hours the pumps discharge more water than is used during the same period by the fourteen largest cities in Canada. The pumping job is claimed to be one of the largest ever carried out in connection with a mining operation. The lake level is being lowered an average of 7 inches a day. By May, it is believed, the shallowest of the three ore-bearing areas—originally 70 feet underwater—will begin to appear as an island. Stripping of the overburden can start soon afterward, and it is expected that the first ore will be shipped by August.

A general description of the Steep Rock project was published in our April, 1943, issue. The operations are being conducted by Steep Rock Iron Mines Limited, which owns 7000 acres of land in and adjoining the lake, which is 40 miles north of the United States-Canada border and 3½ miles from Atikokan, a division point on the Canadian National Railways. It was originally proposed to open the northernmost of the ore bodies by sinking a shaft on the shore to a point below the lake bottom and by driving a gallery through rock to the iron deposit. Considerable work had been done pursuant to this plan when the urgent need for additional iron ore for the war effort suggested draining the lake to get at the ore from above. Aside from making for greater safety, the advantage of this scheme was that it offered the quickest means of producing large quantities of ore. While the first cost would be relatively high, the unwatering plan also promised to be the over-all lowest-cost method of mining the upper portions of the ore bodies. In view of these considerations, the Canadian and United States governments agreed to help finance the undertaking.

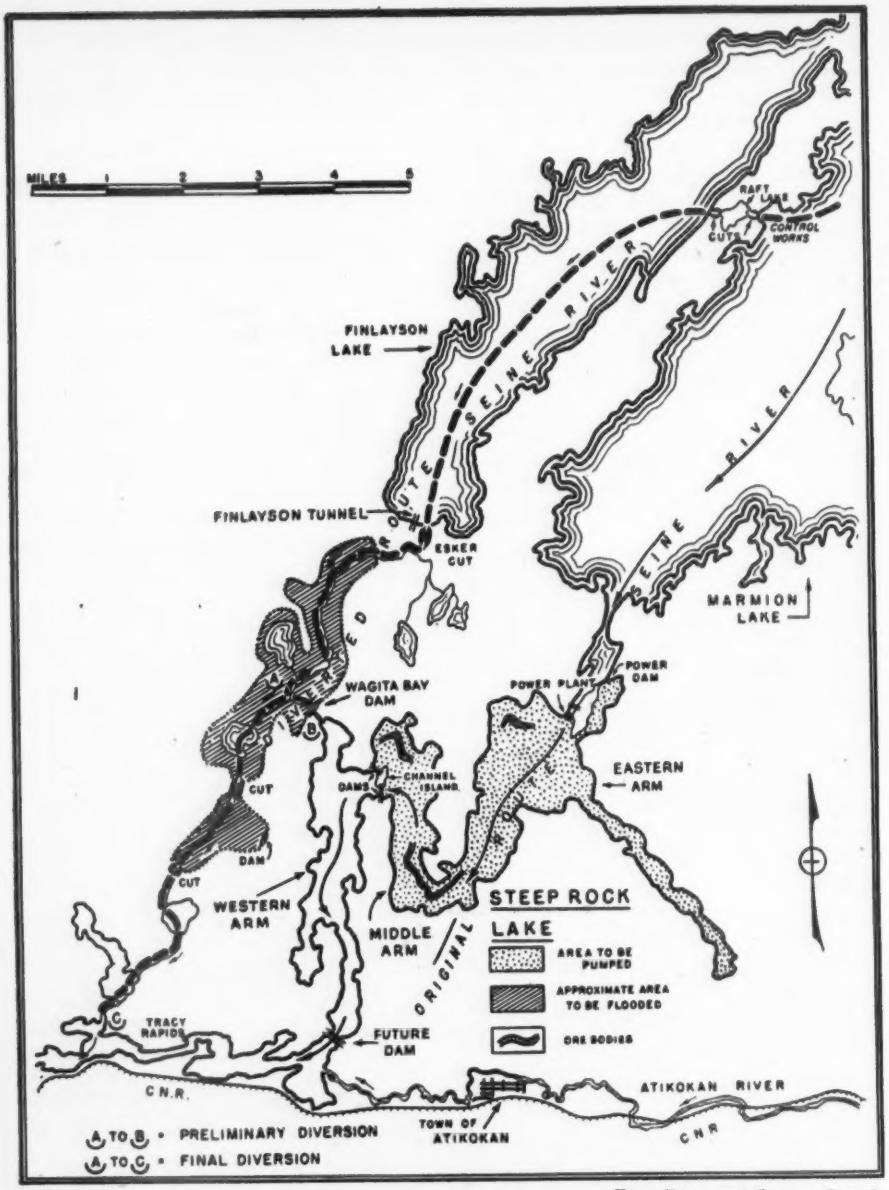
Before the pumping out of the lake could be started, it was necessary to divert the flow of the Seine River and to isolate from adjoining waterways that part of the lake in which the ore bodies occur so as to reduce the volume of water that would have to be removed. Inspection of an accompanying map will make it easier to understand how these ends were accomplished. Steep Rock Lake was fed from the north by Marmion Lake which, in turn, was fed by the Seine River. Marmion Lake was higher than Steep Rock Lake, and at the northern end of the latter a dam had been erected and a 10,500-kw. generating station built by a private company. Arrangements were made to abandon the power plant, and the dam was taken over and heightened to stop water from flowing into Steep Rock Lake. A new outlet for Marmion Lake was made by cutting a channel between it and Finlayson Lake. The latter lies west of Marmion Lake and discharged into it through a connection at the northern end. This necessitated providing an outlet for Finlayson Lake at its southern end. The middle and eastern sections of Steep Rock Lake contain the ore bodies and were isolated from the western arm by constructing two dams which extend northward and southward from Channel Island to the adjacent shores. The Seine River, which now flows from Marmion to Finlayson Lake, has been temporarily diverted through the western arm of Steep Rock Lake. A future diversion to the westward of the present route is planned, as shown on the map.

All the preparatory work just described was completed before last December, and while this was in progress the pumping plant for the unwatering job was being assembled. The first unit started pumping on December 15, and others were put in service at intervals until, by January 4, all were running. They will be operated continually until the water is low enough to permit stripping operations on the southernmost of the three ore bodies. This is the easiest to



LAKE LEVEL GOES DOWN

The picture just above shows the seven pump barges and their fourteen discharge lines after Steep Rock Lake had been lowered about 20 feet. In the other view is the stream made by the combined discharge of the fourteen pumps. Two streams this size would supply New York City with water.



From Water and Sewage, Canada

GENERAL LOCATION MAP

The line of arrows shows the flow through Steep Rock Lake before the diversion was made. The dotted line indicates the man-made route the water now follows and a further diversion that is planned for the future. The pumps are working just off the eastern shore of Channel Island that is connected with the shore by two small dams that were erected to segregate the middle and eastern arms of Steep Rock Lake from the western arm. The southernmost of the three iron deposits will be mined first.

open up and is closest to the railroad. Thereafter, pumping will be done at a slower rate and will be continued until the middle bay of the lake is dry and the two other ore bodies have been exposed.

The part of the lake that is being unwatered had a surface area of more than 4 square miles and a maximum depth of 300 feet. It was estimated that it contained 121,000,000,000 gallons of water, but mining can commence when two-thirds of the content has been removed. The pumps, which are mounted in pairs on seven steel barges, consequently descend as the lake level drops. A constant suction lift is maintained in this way, but the head against which the pumps work increases steadily. When the head reaches 100 feet, the two pumps on each barge will be connected and thereafter operated in series.

The pumps are all alike—of the ALV, 24-inch Cameron Class manufactured by the Canadian Ingersoll-Rand Company, Limited, at its Sherbrooke plant. Each weighs approximately 7½ tons without its direct-connected 500-hp. motor and has a rated capacity of 23,000 gpm. (United States). Twelve of the motors are of the induction type, while the two others, which will be used later for regular mine pumping, are of the synchronous type. They operate at 600 rpm. When the pumps were placed in service, the operating head was 55 feet and each unit delivered 24,000 gpm. Their combined discharge was 336,000 gpm., or more than 2,000,000 tons of water a day. The pumping job involved in righting the foundered liner *Normandie* in New York Harbor was hailed as a big one, and 93 pumps were set up inside of her to make her disgorge the 25,000,000 gallons of water in her numerous subdivisions. The Steep Rock pumping plant handles 18½ times that volume of water every day!

The pumps operate under a static lift of 7 feet, and as a means of priming them each barge carries a Canadian Ingersoll-Rand automatic vacuum primer which removes entrained air from the pump casings and prevents the pumps from losing their prime. The barges were constructed by the Port Arthur Shipbuilding Company, Ltd., and each is 28x48 feet in dimensions, is housed over, and heated. All are anchored just off the eastern shore of Channel Island, and the water is emptied into the western arm of Steep Rock Lake. Each pump discharges through a Naylor spiralweld pipe made up of 24-inch lengths joined with Dresser couplings. The fourteen lines extend to a collecting basin near the eastern shore of the island, and from the basin a 400-foot tunnel, 8x12 feet in cross section, was driven to the western arm of the lake. This arrangement reduced the amount of piping required and also decreased the friction head. Approximately 7000 feet of pipe is provided. This permits using up to 500 feet for each pump as the water recedes and the barges are moored progressively farther from the collecting basin. When the pumps are connected in series, there will be only one discharge line for each pair, thus making 1000 feet of pipe available for each barge. Including the purchase price of the pumps, it is estimated that the unwatering of the lake will cost around $850,000.

The auxiliary construction program that had to be carried out before pumping could be started was one of considerable magnitude and was begun in February, 1943. Twenty-two miles of roads, two large bridges, and several small ones had to be built to gain access to the various working places. The channeling and tunneling operations involved the excavating of 1,500,000 cubic yards of earth and 700,000 cubic yards of rock. All this work was contracted to C. A. Pitts General Contractor, Limited, which delegated some of it to subcontractors. The Hydro-Electric Power Commission of Ontario completed in 180 days a 142-mile transmission line from Port Arthur to the scene of the activities. It supplies the 7000 hp. required for driving the pumps, as well as the replacement power for the pulp company that formerly operated the hydroelectric plant at the northern end of Steep Rock Lake.

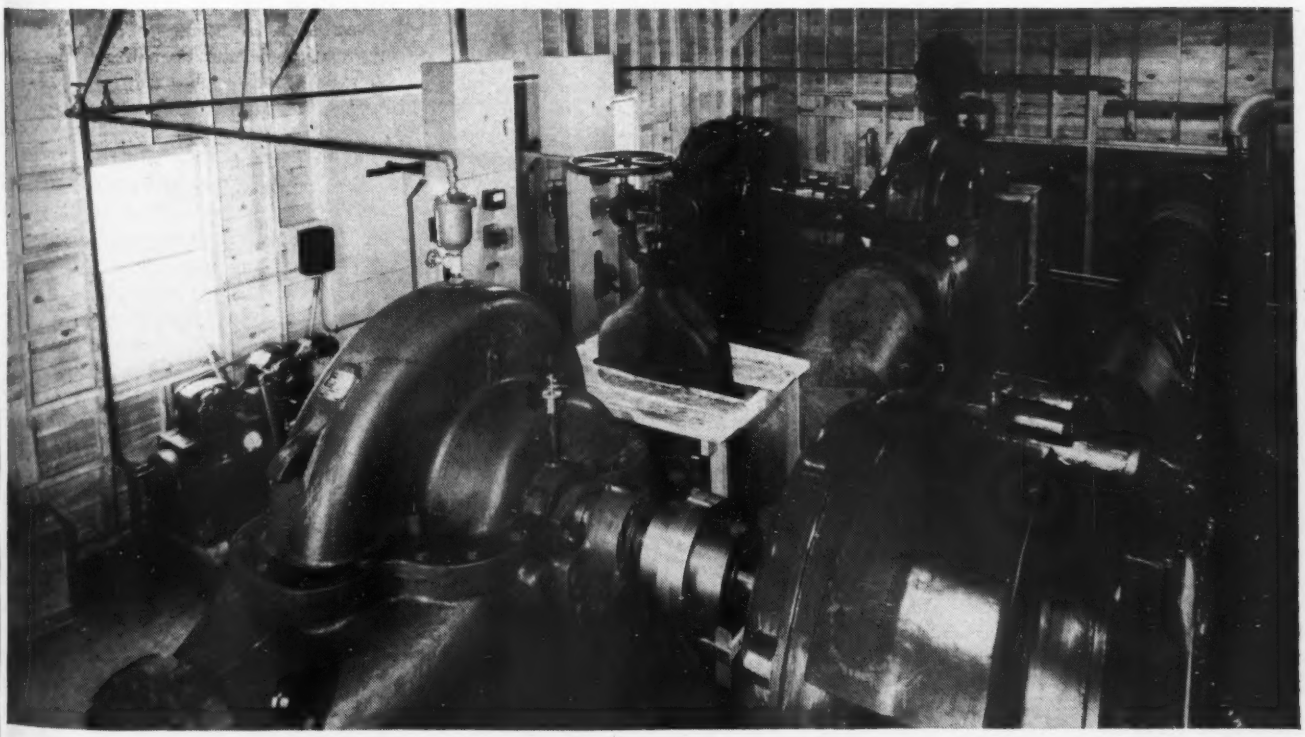
Because Finlayson Lake's water sur-

face was 35 feet higher than that of Marmion Lake, it was necessary to lower it to reverse the flow so that it would by-pass Steep Rock Lake. Calculations indicated that it would be desirable to draw down the water 50 feet. Finlayson Lake had a surface area of approximately 12 square miles, and at its southern end, where the new outlet was to be made, there was a morainal ridge that had been cast up by a glacier in some bygone geologic age. The simplest way to withdraw the water would have been to make a cut through this ridge. If this were done, however, it was realized that the discharge would scour the unconsolidated material from the channel bottom and deepen it to the point where a flood would pour through and cause damage farther down between Atikokan and Fort Frances.

In order that the outflow might be controlled, it was decided to excavate a tunnel in the solid rock underneath the glacial deposit. This was started about 1000 feet south of the southern tip of the lake, and is 10x12 feet in section. It was driven on an 18° downward slope for 290 feet to get into the rock, then on the level for 870 feet, and, finally, on an upward slope of 50° for 120 feet so that it would emerge at the lake bottom 60 feet below the water surface and about 300 feet from the south shore. All but the last stretch was drilled with six Ingersoll-Rand DA-35 power-feed drifter drills. The average round consisted of 48 holes, 8 feet deep, and the daily progress averaged two rounds, netting an advance of 17 feet in hard greenstone. No timbering was required. The steeply sloping section was driven as a raise, using Ingersoll-Rand R-51 stopehamers. A diamond-drill hole was kept well in advance of the face at all times to give warning of any water flow from the lake. The final 10 feet of rock was left in place as a plug, and when all was in readiness it was blown out with a single blast. The tunnel was started on March 20, 1943, and completed on July 23. It was driven by Patrick Harrison, of Montreal, who also did the other tunneling included in the program.

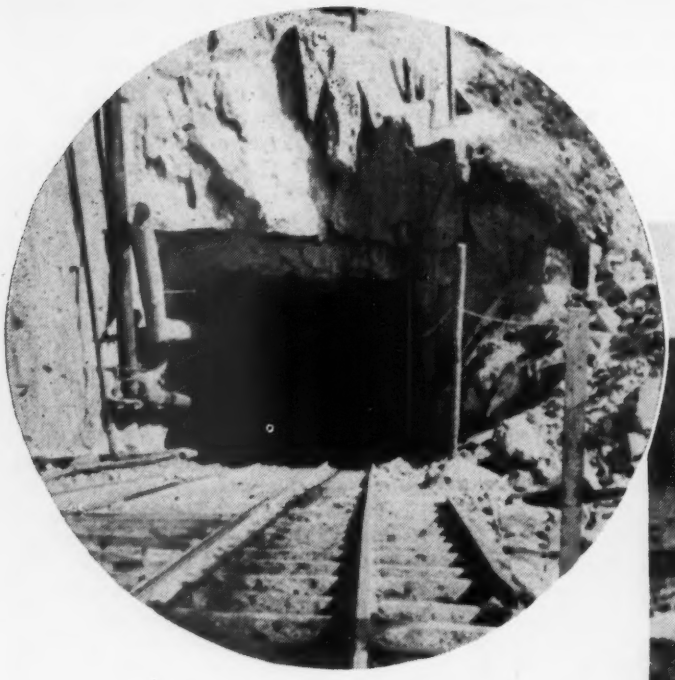
The tunnel restricted the outflow, as had been planned, and enough water was discharged through it to draw down the surface of Finlayson Lake by 53 feet. Meanwhile, work had been started on the cutting of the channel that was to serve as the permanent outlet. This was necessary, because the tunnel would not have sufficient capacity to handle the flow of the Seine River during flood periods. The channel is known as the Esker Cut and will be finished before the river reaches high-water stage this spring. It will be 1900 feet long, 200 feet wide at the bottom, and have a maximum depth of 140 feet. It has involved the removal of 1,200,000 cubic yards of earth and some 70,000 cubic yards of rock, most of the latter from the northern end adjacent to the lake.

In excavating the channel between Marmion Lake and Finlayson Lake, advantage was taken of a small body of water, known as Raft Lake, lying between them. Raft Lake was roughly circular in shape, about ½ mile in diameter, and had a maximum depth of 80 feet. Its water surface was 2 feet higher than that of Finlayson Lake and it contained about 600,000,000 gallons of water. To permit digging the connections in the dry, Raft Lake was unwatered with nine pumps of varying sizes and types. Operations were then started on a channel eastward to Marmion Lake and another westward to Finlayson Lake. Both of these are 100 feet wide at the bottom, have sheer walls up to 70 feet high, and entailed the removal of approximately 550,000 cubic yards of material, of which 500,000 cubic yards was rock. The Raft Lake-Marmion Lake channel is 1000 feet long and was excavated by drilling vertical holes from the surface with churn drills. The Raft Lake-Finlayson Lake channel is 1600 feet long and has a maximum depth of 90 feet. It was excavated under a subcontract by Boyle Brothers Drilling Limited by means of a diamond-drilling system similar to that used in some underground mines. A tunnel was driven on the center line of the channel and with its bottom 2 feet below the grade of the cut, and from it were drilled closely spaced flat diamond-drill holes extending to the side walls of the cut. At the same time, wider-spaced vertical holes were being drilled down from the surface to the top of the lower part of the "slash" cut. The rock broke well when blasted and could be easily loaded by power shovels.



INTERIOR OF PUMP BARGE

Each pump is driven at 600 rpm. by a 500-hp.motor. The vacuum-pump priming unit for both water pumps is shown against the wall at the left. The pump compartment is tightly constructed, heated, and well lighted.



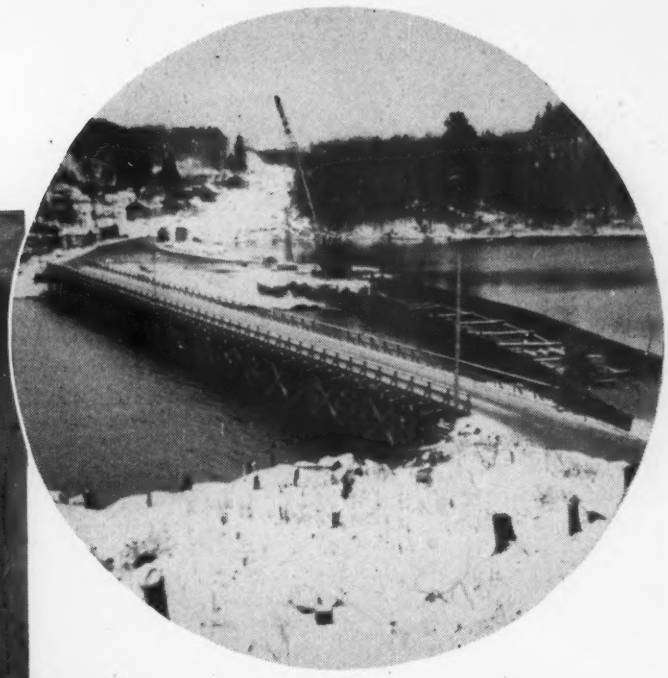
CONSTRUCTION SCENES

At the top is the portal of the tunnel that was driven to tap Finlayson Lake so as to reduce its level 50 feet before diverting into it the flow of lower-lying Marmion Lake. Esker Cut, shown under construction at the right, was excavated to serve as a permanent outlet for Finlayson Lake. Some of the nineteen air compressors that were used about the job are shown at the bottom.

To hold back the water until everything was in readiness for its diversion, rock was left in place at the eastern end of the east channel and at the western end of the west cut. These were honeycombed with drill holes and loaded with dynamite. The smaller plug, adjacent to Finlayson Lake, was 10 feet high and contained 2000 cubic yards of rock. The other one was 30 feet high, contained 7000 cubic yards of rock, and was perforated with about 5 miles of drill holes loaded with 600 cases, or about 15 tons, of dynamite. The plugs were removed on January 26.

The smaller plug was blown out first, without incident, and the larger one was touched off an hour later. The spectators retired to a respectable distance and took refuge behind a heavy barricade. The man who was to push the plunger of the electrical blasting machine crawled inside the steel bucket of a power shovel that had been laid on its side at a point about 400 feet from the plug. He was able to watch the result through a rivet hole in the bucket. The blast showered the countryside with rock fragments, and one huge piece was hurtled into Marmion Lake. The plug was completely disintegrated, and a wall of water 25 feet high rushed into the channel. A spillway, 900 feet long and containing control works, had been built of concrete in the bed of Raft Lake to regulate the flow of the Seine River for the use of power plants farther downstream, and shortly after the second plug was blown out, the water was flowing over this spillway and on down the new course prepared for it. The flow through Steep Rock Lake had been stopped on December 10 after the power dam at its northern end had been raised with a steel-and-wood superstructure. Pumping was begun five days later, and by March 15 the water surface had been lowered 50 feet. In addition to rock drills, various other air-operated tools were utilized in carrying out the diversion program. To furnish the power needed for their operation, there were scattered about the job nineteen Ingersoll-Rand stationary and portable compressors with a combined capacity of 7400 cfm.

As soon as the water recedes enough to expose the area where mining is to commence, the job of stripping the overburden will be started. It is planned to excavate a depression in the surface and to remove the earth with a 15-inch, 750-hp. suction dredge. Three hydraulic monitors will sluice the material into the depression, using water to be supplied by one of the pump barges, and the dredge will discharge at a point in the lake bottom that is not underlain with iron ore. Four power shovels, and possibly scrapers operated by draglines, will serve to load rocks and other material that cannot be handled by the dredge.



TUNNELS, DAMS, CUTS

The water pumped from Steep Rock Lake flows into a collecting basin on Channel Island and thence through a tunnel to the western arm of the lake. The view at the left shows the 8x12-foot tunnel that is 400 feet long and was driven in 23 days. In excavating the western section of the diversion channel between Marmion and Finlayson lakes, a tunnel (bottom picture) was driven with its lowermost 2 feet beneath the finished cut level to permit drilling from the bottom as well as from the top. Two shafts were sunk to expedite tunneling operations by opening up additional faces. To facilitate the construction work and preparation of the pump barges on Channel Island, an access bridge (top picture) was built to the island from the lake shore. Under construction beyond the crossing is one of the two dams that extend from the island to the nearby shore to isolate the section of the lake that is being pumped out.

The depth of the overburden throughout the ore-deposit zone ranges from 20 to 120 feet, and it is estimated that 8,000,000 cubic yards will have to be handled but that mining can begin when 300,000 cubic yards has been removed. It is expected that excavating will not have to go deeper than 40 feet to gain access to all the ore that can be mined during the first year of operations. The schedule calls for the production of 500,000 tons in 1944, 1,000,000 tons in 1945, and a gradual increase to 2,000,000 tons annually thereafter. Of the two other ore bodies that will be uncovered, one lies under from 100 to 250 feet of water and overburden and the other is 400 feet below the original water level. Borings indicate that the three deposits will yield 32,000,000 tons of ore, but the prospects are that they will prove to be even more extensive when thorough prospecting can be undertaken.

The Canadian National Railways is constructing a 3½-mile spur line from Atikokan to the site and promises to have it completed by the time mining starts. Work is also in progress on an ore-loading dock at Port Arthur. As a part of the Steep Rock mining development, the Canadian National Railways is building 250 cars in which to haul the ore to the lake port.

The Steep Rock ore deposits first gained public attention in 1905, when Prof. H. L. Smyth of Harvard University conducted investigations that indicated their presence. The preliminary drilling that proved their existence was done by the Steerola Exploration Company, predecessor of the present operating concern.

Cyrus S. Eaton of Cleveland, Ohio, is chairman of the board of Steep Rock Iron Mines Limited. Maj. Gen. D. M. Hogarth is president, and Col. G. G. Blackstock is executive vice-president. Watkin Samuel, chief engineer, is in general charge of the work that has been described.

Lime Kilns in Quarry Raises

*H. J. Pitts**

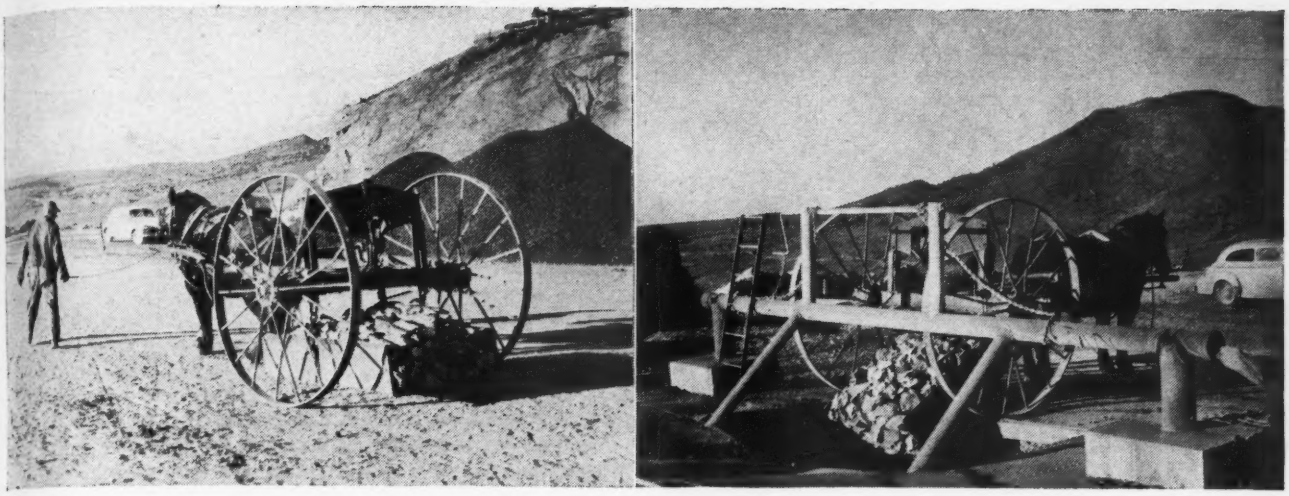
AMONG the varied activities engaging the attention of the Chief Consolidated Mining Company in the Tintic Mining District of Utah is the operation of a lime quarry and hydrate plant at Saddle, 2 miles northeasterly from Eureka City on the Tintic Branch of The Denver & Rio Grande Western Railroad. The work done there has had little publicity, and no special salesmen are employed to push the plant's products because its "Chief Brand" high-calcium hydrate is of such a quality that it has created and maintained for itself a consistent demand by railroads and concentrating mills, smelting, oil-refining, and steel-producing companies. The raw stock is a part of the Gardner Formation—Lower Mississippian limestone—locally known as the pink beds, and has an average content of 2 percent insolubles, 0.4 percent Fe_2O_3-Al_2O_3, 96 percent $CaCO_3$, 0.08 percent $MgCO_3$. The finished products, specified by the purchasers, range from 89 to 93 percent available calcium hydrate with no objectionable impurities.

*Chief Engineer, Chief Consolidated Mining Co.

QUARRY AND WORKERS

The numbers in the top picture indicate: 1- Top of kiln at quarry floor, with coke pile nearby; 2- compressor house; 3- portal of adit to kiln; 4- burned lime haulage road; 5- coke service road; 6- hydrate plant. The small views show stone as shot down being broken up with a paving breaker (left) and a sledge hammer (above). No piece with a dimension greater than 6 inches is placed in the kilns.

The quarry is in the side of a steep canyon and about 400 feet above a creek bed. Disposal of waste is therefore an easy matter. The face is now approximately 150 feet high, and an excellent floor is maintained. Quarrying is carried on in the usual manner. Holes up to 20 feet in depth are drilled for primary blasting with Jackhamers. Large masses brought down in this way are broken up by paving breakers into sizes that workmen can reduce manually to fragments not exceeding 6 inches in dimension. This material is loaded into 25-cubic-foot pans that are swung under high-wheeled quarry horse carts, hauled a



HAULING TO KILNS

Sized stone is loaded at the quarry face into steel pans and each pan is suspended from a horse-drawn cart, as illustrated at the left. The picture at the right shows a pan being dumped into the top of a kiln.

short distance to the top of a kiln, and there dumped against a suspended baffle plate that causes the charge to be spread evenly in the kiln. Air for all purposes about the quarry is supplied by an Ingersoll-Rand 10x10-inch compressor driven by a 40-hp. motor.

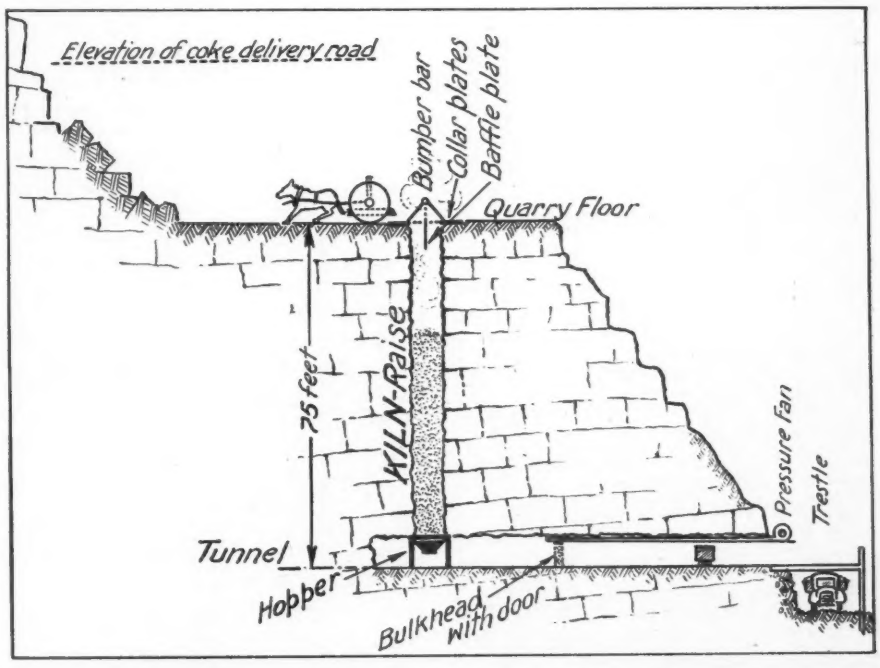
The kilns in use are unique. At the outset of the operations the company installed at the hydrate plant two vertical kilns with elaborate linings and charging equipment. But their maintenance proved to be so costly, and shutdowns occasioned by the need of relining or of changing or repairing mechanical parts were so frequent, that it behooved the management to find less expensive and less complicated means of burning its lime. The problem was solved by driving a tunnel under the quarry—75 feet vertically below it—from which 6x6-foot raises are run from time to time up to the quarry floor. These raises are unlined and are fitted at the tunnel level with suitable hoppers and at the surface with iron collar plates, bumping bars, and suspended baffle plates. They serve as kilns and operate continuously and efficiently at a minimum cost.

A pressure fan with a 15-hp. motor supplies the kilns with the necessary air. It is located at the mouth of the tunnel, and some distance in from the portal is a concrete bulkhead provided with a door through which mine cars may pass. But when this door is closed, the blower air is forced through the bulkhead and through the charges in the kilns. Coke, usually of pea size, is the fuel used and is hauled by contract from a valley steel plant at comparatively low cost. It is piled on the quarry floor near the tops of the kilns and is fed into them in the proportion of 1 to 4 of lime, by weight.

As the lime is burned, it is drawn off into mine cars and dumped at the mouth of the tunnel into trucks that carry it a short distance to the bins at the hydrater. Being unlined, the sides of the kilns burn, too, and in time become inconveniently large. But inasmuch as the raises are run through the same material that is fed into them, there is no danger of dilution, and the expense involved in driving a new raise is nominal. Only two such kilns have been abandoned in the last twenty years.

The hydrating plant is of standard type—up to date in every respect. It is housed in a substantial steel building containing the necessary bins, elevators and conveyors, crusher, hydrater, pulverizer, exhaust fan, bagger, etc. All the machinery is powered by electricity, each unit being served by a separate motor. Water is delivered by gravity from a nearby spring. The whole plant is as automatic as it is possible to make it, and for convenience in loading shipments, the main floor is level with the floors of the railroad cars. It has a capacity of 2000 fifty-pound bags per shift and storage space is available for 30,000 bags.

The novel arrangement whereby ordinary raises in limestone are made to serve in place of especially constructed kilns is evidence of the effective planning on the part of Cecil Fitch, president and general manager of the company, and of his coöperating organization. Much credit is due to Arnold Robinson, plant foreman, for the continued smooth operation of the kilns.



SECTIONAL VIEW SHOWING KILN CONSTRUCTION

Johnstown Ends Floods

JOHNSTOWN, in the State of Pennsylvania, is entering upon a new and brighter era of existence. For the first time since Joseph Johns founded a settlement there 144 years ago, the community is free from the menace of floods. Five years of construction by U. S. Army Engineers has provided means for safely handling the largest recorded flows of the two mountain streams that come together in the heart of the city. The cost of the work—$8,670,000—was but a fraction of the loss through damage wrought by high water in bygone years.

In May, 1889, the breaching of a dam 9 miles above Johnstown released a wall of water that snuffed out 2300 lives and swept away $10,000,000 worth of real estate. Because it was the first major catastrophe after telegraphic service became available to newspapers, the whole country immediately knew all about it. Overnight Johnstown acquired the unwelcome title of the "Flood City," and this was perpetuated through books, vaudeville references, and, finally, motion pictures. All hope that time might temper the taint was removed when high water again inundated the business section on March 17, 1936, causing fifteen deaths and $40,000,000 property damage.

Johnstown's merchants went to work to clean up the debris, to rebuild their stores, and to replenish their stocks. At the same time they resolved to put an end to Nature's rampages. Enlisting Federal aid, they inaugurated the program of construction that has recently been completed. Sturdy concrete walls now stand ready to confine the waters to the streams' channels, and the Army Engineers give assurance that the city will never again suffer from flood.

Before settling down to enjoy its security, Johnstown proposes to tell the world what it has done. It has adopted a slogan: "Flood-free Johnstown—a good place to live, to work, and to do business," and has engraved it on a shield that is reproduced on letterheads and literature. Under the auspices of the city's advertising club, residents of the community are writing thousands of letters to their friends, relatives, and business acquaintances throughout the country to impress upon them that Johnstown has removed the blot from its name. The city has a population of 100,000, and hopes to grow much larger by attracting manufacturers who previously shied away from it because of its bad reputation.

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Mining in 1943

THE announcement that the 1943 production of minerals was the greatest ever recorded in the United States has occasioned little surprise. With the machinery of war plants turning at top speed, it was a foregone conclusion that the mines would exceed all previous efforts, because the Juggernaut of Mars runs on metals. Without ample supplies of iron, steel, copper, lead, zinc, aluminum, and many other metallic elements, our output of ships, planes, tanks, guns, and ammunition would bog down. Neither could we erect and equip the establishments that are producing aviation gasoline, synthetic rubber, high explosives, and the countless other things that are necessary to wage war. Of vital importance, too, are the nonmetallics such as fluorspar, limestone, feldspar, silica, and gypsum.

When the full story can be told of how the Government and the mining industry joined hands to search for and to develop untapped deposits of strategic minerals, it will make interesting reading. Meanwhile, we can reflect upon the changing pattern of mineral output that has followed in the wake of the war. It is only natural that greatest emphasis has been placed on getting out the base metals, the light metals, the alloying metals, and the special-purpose metals such as titanium, tantalum, mercury, etc. While their star has been ascending, that of the so-called precious metals has been going into an eclipse. Being luxury metals, gold and silver have been shunted aside, just as other luxuries have been curtailed.

Considerable silver is still mined as a by-product of copper, lead, and zinc; but little gold originates in this manner, and gold mining as such has virtually ceased to exist. The extent to which gold production has been stifled is strikingly illustrated by the fact that California's 1943 output of the yellow metal was lower than that in any year since James W. Marshall made his electrifying discovery of auriferous gravels on the American River 96 years ago. Substantially all of last year's yield came from placer mines. In South Dakota and Colorado the situation has been much the same as in California. In 1943, the three states combined produced gold worth only about $14,000,000, which is approximately one-sixth of their 1939 output.

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A Notable Safety Record

APROPOS of an editorial in our March issue on safety in industry and of an advertisement in the same number calling attention to a quarry that operated 213,800 man-hours without an accident, a reader has sent us a copy of the employee magazine of the Norfolk & Western Railway Company in which an outstanding safety record is reported. Employees of the Roanoke, Va., machine shops of the road worked from February 7, 1939, to December 14, 1943, without a reportable injury, amassing the impressive total of 4,631,277 man-hours. This is the best no-accident record ever made on the line. It goes far to prove that accidents can be prevented if people think they can.

Bomb Fuses Tested Under Simulated Flight Conditions

WHEN an American plane unloads a "stick" of fragmentation bombs, it's a pretty sure bet that it will be safely away by the time their firing pins are released. These projectiles are designed to scatter fragments upon impact, and to protect the machine that drops them each bomb has a fuse on its nose to prevent premature explosion. It's a small cylindrical device with vanes that must revolve a predetermined number of times to loosen the safety device which, in turn, releases the firing pin that sets off the bomb upon striking a target. If this cycle of operations does not take place, the bomb is a dud.

Obviously, much depends upon the quality of the fuses, and this is assured in the East Springfield, Mass., plant of the Westinghouse Electric & Manufacturing Company by testing them under conditions that are akin to dropping them from a plane in flight. Each day a certain number of fuses for 20-pounders is taken from the final assembly line and placed successively in a narrow wind tunnel, 3 feet long, in which they are exposed to gales blowing at the rate of 300 to 800 miles an hour. When properly positioned, the technician presses a button that starts an automatic timer and opens a magnetic valve. As the valve opens, a burst of compressed air rushes from an air receiver through a reducing nozzle to the fuse, whirling the vanes at its tip and releasing the safety device. The latter flies off, and as it does so it causes a beam of light to strike a photoelectric cell which closes the valve and stops the timer by an electronic device.

TESTING BOMB FUSES

Part of the wind tunnel in which bomb fuses are exposed to man-made gales of 300-800 miles per hour to determine their fitness for service. A technician is shown inserting a fuse prior to sending a blast of compressed air through the tunnel. An important outcome of these tests is an improved type of fuse made of steel instead of aluminum, with a consequent monthly saving of 22,800 pounds of the latter metal.

Performance is gauged by the speed with which the safety device is released. This is known as the "arming" time, which is recorded by the automatic timer in intervals as small as 120th of a second. To pass the test, a fuse must function within a predetermined period, depending upon the velocity of the wind. This is determined by the drop in air-receiver pressure and the length of time the magnetic valve is open. Until this method was introduced, the vanes were spun mechanically at a rate equivalent to an airplane speed of 75 miles an hour, not enough to reveal functional defects that might spell disaster to an airplane on a bombing mission.

Advantages of Stemming

IN A REPORT entitled *Stemming in Metal Mines*, by W. G. Agnew, the U. S. Bureau of Mines discloses the findings of a series of tests at the Mount Weather Testing Adit near Berryville, Va. Thirty standard 4-foot rounds were fired—ten with 80 sticks of dynamite and no stemming, ten with 80 sticks of dynamite and sand stemming, and ten with 64 sticks of dynamite and sand stemming. Two cartridges of stemming were placed in each hole, and the explosive was 40 percent ammonia gelatin. The third group of tests, which was identical except for the amount of dynamite used, served as a check on the accuracy of the observations. According to Dr. R. R. Sayers, director of the Bureau of Mines, rounds of shots fired without stemming broke down only 72 percent as much rock as shots with sand stemming. In addition, more fine rock was produced, which is a decided asset in metal mining, and the cost per ton of rock broken and per foot of advance was proportionately reduced.

Impervious Clothing Helps Curb Skin Diseases

OF ALL industrial diseases, those affecting the skin are said to be the most prevalent, accounting for 65 to 70 percent of all persons disabled because of their occupations. The high rate of incidence is a direct result of our vast production effort in which thousands of factory workers are exposed to oils and solvents. Although permanent disability from dermatitis and folliculitis is uncommon, yet they present a hazard to health and are a cause of absenteeism.

Until recently, few industrial plants had any program to combat these diseases, and those unfortunate enough to be allergic to oils or solvents were given other jobs to do. Now the accent is placed on prevention rather than on cure, and workers are often tested for allergies before they are assigned to their duties. Those that are sensitive to oils and solvents are protected against them by encasing them in flexible, transparent safety garments including hoods, aprons or smocks, sleeve guards, and gloves. Even shoes may be coated with a solution of the vinyl resin of which the clothing is made. The substance is known as Compar and is a derivative of limestone, coal and air. It is claimed to be impervious to organic solvents such as sulphur-base cutting oils, kerosene, paint, lacquer, cleaning and degreasing compounds, as well as to many inorganic solvents and to industrial, refrigerant, and military gases.

HAND AND FOOT PROTECTION

The gloves and footwear shown are oil and solvent resistant and, together with other garments of the same type, are a form of industrial insurance against skin affections. The gloves are available in four sizes and three lengths and have curved fingers for freedom of movement. Dipping shoes in a solution of Compar, made by the Resistoflex Corporation, does not cause them to lose their flexibility.

Beadlocks Save Tires

NO FLATS

Equipped with a beadlock, as shown, a tire with a punctured tube can roll along for miles, if necessary, without damage. The steel bands are being made for the exclusive use of our armed forces and are adding measurably to the service life of pneumatic tires on combat vehicles.

MOTORISTS may well be interested in a steel band or beadlock that is being produced by the Goodyear Tire & Rubber Company for the armed forces because it permits driving a car with a punctured tube without ruining the tire. However, they will have to wait until the war is ended before they can avail themselves of this protective device—in fact, the type now being manufactured is not suitable for drop-center tire rims.

The band, as the accompanying picture shows, is split at one point to facilitate application and is held in place by a steel hinge that serves also to stabilize the beadlock when it is collapsed and to guide it when it is being slipped into place. It holds the tire apart and locks it to the rim, thus preventing a flat and allowing the tire to turn normally after the tube is punctured. Furthermore, by imbedding itself in the beads, the band holds them firmly in place on the bead seat or against the rim flanges. As a result, whipping and wobbling that ordinarily chew up a deflated tire are eliminated and the driver can keep his car under control. According to reports from war zones, beadlocks make it possible for tires with punctured tubes to stand up for miles until repairs can be made in safety.

Mudless Dirt Roads

CLIMAXING several years of laboratory work and field tests, the Hercules Powder Company has announced the discovery of a resin compound that will, it is claimed, effectually stabilize the soil for years—prevent the formation of mud in wet weather. The new material is called Stabinol, and when mixed with a few inches of topsoil gives dirt roads airplane landing fields, construction areas, etc., a surface from which the water will drain off or evaporate. It also checks the capillary rise of ground moisture and can therefore be used to advantage in treating soil that serves as a base for main highways with hard surfaces. Only fractional amounts of the compound are required, usually about 1 percent of the total material to be waterproofed.

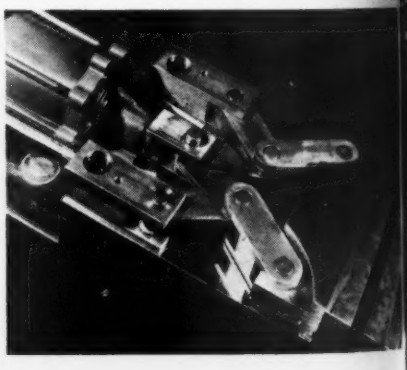
At the Hercules soils laboratory in Wilmington, Del., test cylinders of stabilized soils are submerged in water to chart moisture absorption. Some of these have remained underwater for 90 days and longer without showing any signs of softening into mud; and cylinders 2 inches in diameter and not more than 2 inches high, that have been compacted to the maximum density, will support the full weight of a man after having been totally submerged for long periods.

The field work has been carried on in coöperation with city and state highway departments, and resin-stabilized roads are to be found in Florida, Mississippi, Georgia, South Carolina, Delaware, and Ohio. Furthermore, both the U. S. Army Corps of Engineers and the U. S. Navy Department have supervised the stabilization of soils on projects in this country and abroad. The effectiveness of the method has been proved from every angle, and it is reported that roads laid down nearly five years ago are still waterproof and that trucks can travel over them during or after a rainstorm without churning up mud or leaving ruts.

Automatic Air Vise for Milling Machines

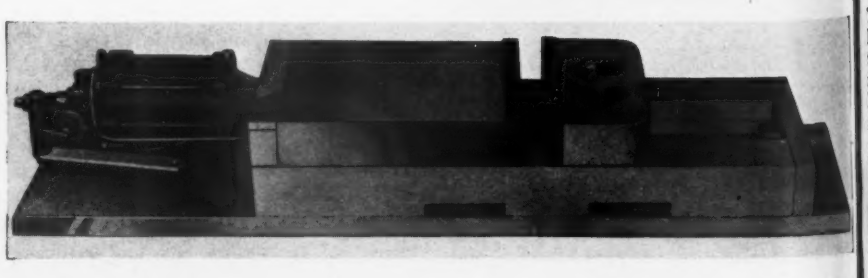
CLAMPING pressures from 1 to 40,000 pounds are claimed for the automatic milling-machine air vise announced by The Bellows Company. The unit is powered by means of a Bellows Senacon air motor operating through a predetermined leverage on a line pressure of 80 to 100 pounds and applies and maintains any desired degree of pressure with an average consumption of less than 1/10 cubic foot of free air per cycle. The moving jaw has a travel of ⅞ inch while the fixed jaw is adjustable within 4½ inches, giving a maximum jaw opening of 5⅜ inches. A double-acting valve, which is an integral part of the vise, has an adjustable control lever that may be synchronized with any moving part of a machine for fully automatic opening and closing of the vise. Output can thus be maintained, even in the case of women workers, without noticeable slackening due to end-of-shift fatigue.

The CVH-60, as the unit is designated, is equipped with an automatic lubricator that bathes all enclosed parts and linkage with an oil mist from the motor exhaust. It fits any standard milling machine without drilling holes or otherwise altering the latter and is said to cut loading and unloading time as much as 40 percent. Milling-machine men say that these operations, together with table travel, normally account for all but nine minutes of each working hour.



VISE AND TOGGLES

The unit, shown in its entirety at the bottom, is 27¾x6 inches in size and equipped for automatic functioning with an air motor, double-acting air valve, and control lever (left). The latter is adjustable and permits operating the valve from any angle in any plane. At the right is a close-up of the toggle arrangement through which clamping pressures as high as 40,000 pounds are obtained.



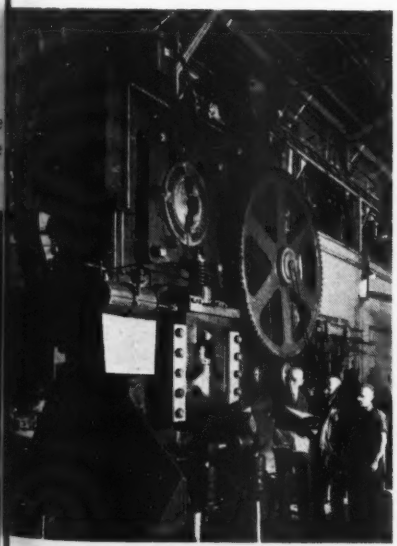
Industrial Notes

Metal that has become cold through exposure, or that is scale-covered, wet, or oily, can be lettered for purposes of identification with a new Paintstik that is said to make weather- and fade-proof markings. It comes in a range of colors and is put out by Markal Company.

Stainless Steel is the name of a 16-mm. sound motion picture produced by the U. S. Bureau of Mines in coöperation with the Allegheny Ludlum Steel Corporation. The film is available for free showing to industrial and institutional training classes, civic organizations, etc. Application should be addressed to Graphic Services Section, Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

Up-to-date dehairing of hogs is a clean and quick process and involves the use of a resin chemical that has been produced in the laboratory of the Hercules Powder Company. The liquid is applied by dipping or air spray, encasing the carcass in a plastic suit. When this is lifted and peeled off, the bristles and hair come off with it. The plastic, which is named Brisgo, can be remelted for reuse.

Kennametal, Inc., is making a file with a 4x¾-inch carbide surface backed by steel and with an over-all length of 11 inches. Designated the F76, it is designed for cutting high-carbon, high-chromium steels, cast iron, and brass and for use in connection with machines set for speeds suitable for carbide-tool application. In this service, the file (only one size is available at present) is said to outlast one of steel from 50 to 200 times.



WEIGHS EIGHTY TONS

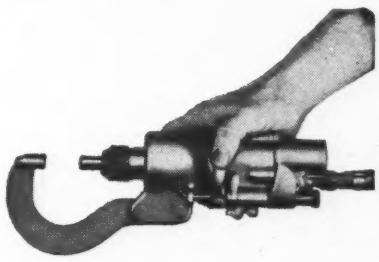
The huge billet shear shown here was built by the Buffalo Forge Company for the Timken-Detroit Axle Company and is believed to be the largest of its kind. It is driven by a 125-hp. motor through multiple V-belts, has an air-operated clutch and hold-down, and is equipped for automatic pressure lubrication. With a pressure of 4,500,000 pounds on the knives, the machine shears 10-inch steel bars at the rate of six cuts a minute.

Alberene Stone Corporation has developed ingenious laboratory equipment by which samples of one kind or another can be given salt-spray tests in accordance with Army and Navy aeronautical specifications. The samples are suspended on racks inside a 34x21x25-inch soapstone housing in a structural outer case containing, in addition, a small reservoir for the salt solution. The latter is forced by compressed air from the storage tank through two washing towers to a nozzle, whence it is delivered in the form of a vapor to the test chamber.

Something new in shipbuilding materials in the form of ceramic-coated metal is being produced by Seaporcel Corporation. The ceramic is applied to light-gauge Armco sheet iron and fused in furnaces at 1550°F. According to the manufacturer, the material can be cut by hand or hack saw, squaring shears, or by gas torch; drilled and joined with tubular rivets or by tack welding; and is at present being made into panels for bulkheads, hull linings, deck heads, etc., and into such marine supplies as mess-table tops, food containers, dish racks, and washroom troughs. It comes in colors in matte to dull-gloss finish and will not peel, chip, or crack even when rolled to a radius of 3 inches or more.

Norton Company has announced that its 57 Alundum grinding wheels are now available not only for critical but also for general use as the result of increased production facilities. The abrasive of which they are made is more friable than regular Alundum abrasive, providing a wheel that is said to have a fast, cool cutting action and that tends to keep itself sharp, to hold its shape, and to require few dressings. Wheels of 57 Alundum come in a wide range of grain sizes, grades, and structures in both the regular and the patented Norton BE vitrified bond. They are suitable for cylindrical, centerless, and internal grinding, for snagging, and especially for crankshaft grinding where it is important that the wheel corner stand up well.

What is described as a revolutionary development in aircraft riveters has been announced by Ingersoll-Rand Company. The Air-Buck, as it is designated, is a 1-man tool, its outstanding feature being a yoke that does the bucking-up. Riveting is further simplified by a valve lever adjuster by means of which the hammer unit is shut off the instant the driven head of a rivet has reached a predetermined height. This height is maintained automatically, regardless of the number of rivets driven, until the valve-lever



setting is changed. The yoke is attached to the rivet-hammer casing with two bolts to facilitate interchange with yokes of different sizes. The standard type has a reach of 2½ inches and a gap of 1⅜ inches for rivets having a driven length of ½ inch or under. Special sizes with a reach of 25 inches or more can be readily made by the user. Rivets can be driven from either the yoke or the rivet set, one or the other being cupped for that purpose. Although designed primarily for the aircraft industry, the application of the Air-Buck is not confined to that field. It can be utilized to advantage wherever aluminum rivets from ⅛ to 7/16 inch in diameter have to be driven and where it is possible to use a yoke-type tool.

As many as 158 different parts of internal-combustion engines built in the shops of an American company are now being hardened by the electrical-induction process that is finding increasing application in metal-working plants in the country. Necessity brought about the changeover that is helping to make it possible to maintain production with reduced manpower. The heating unit requires the services of but one operator and does its work quickly and without distortion. It involves passing a high-frequency current through an inductor or heating coil into which the part to be hardened is inserted, surrounding but not touching it. The coil is wound to fit the contour of the work, usually with a clearance of 3/32 to ⅛ inch. When in use, water passes through the inductor to keep it cool, the only heat generated being in the work itself. The rate of power input and the length of time it is applied control the degree of hardening, which can be accurately gauged as to depth and width. Quenching is done by directing jets of water against the heated surface through orifices in the coil. The resultant product requires a minimum of grinding and machining.

NAYLOR PIPE GULPS 2,000,000 TONS OF WATER DAILY TO UNCOVER IRON DEPOSITS UNDER CANADIAN LAKE . . .

Here's a dramatic demonstration of light-weight pipe performance on a tough assignment.

In the project of de-watering Steep Rock Lake, more than a mile of large diameter Naylor Lockseam Spiralweld Pipe is literally carrying away the lake at the rate of 7 inches a day. In all, this distinctive light-weight pipe must handle 121 billion gallons of water before the deposits of iron ore can be tapped.

Naylor's exclusive structural advantages enable this light-weight pipe to make light work of gulping 2 million tons of water a day.

That's why Naylor is specified for such services as dredging, hydraulic sluicing, de-watering, ventilating, exhaust and intake and other applications of high and low pressure air and water lines.

Only NAYLOR PIPE Combines All These Advantages

- Always accurate in diameter.
- Concentric ends match correctly.
- Easier to install.
- Holds true cylindrical form.
- Stays tight and leakproof.
- Stronger—safer.
- Handles jobs normally requiring heavier-wall pipe.
- High salvage value.
- Light weight saves steel.
- Cuts maintenance costs.
- Saves money.

Sizes: 4" to 30" in diameter—all types of fittings, connections and fabrications.

Naylor

NAYLOR PIPE COMPANY
1245 EAST 92ND STREET • CHICAGO 19, ILLINOIS

In war or peace

B.F.Goodrich

FIRST IN RUBBER

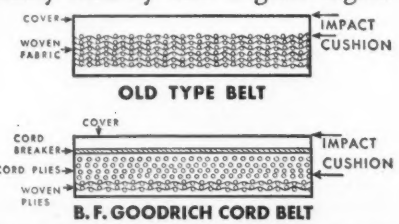
Ore-unloading cord belts by B. F. Goodrich outperformed former belts more than 100%

Double the tonnage carried for 25% increase in belt cost

THE average tonnage record for conveyor belts on these ore unloaders was 3,490,000 tons — until the first B. F. Goodrich cord conveyor belt was installed at the opening of the 1939 lake season. Because the cost of the B. F. Goodrich belt was 25% greater, the owner knew it would have to carry 4,300,000 tons to earn its premium price.

Today, after five full seasons of use the belt has carried *7,500,000 tons — and is ready for further regular service this spring.* Two other cord belts, installed later, have carried 6,000,000 tons and 5,100,000 tons. They, too, are ready for continued heavy-duty service.

The diagram shows why B. F. Goodrich cord belts outperform ordinary belts by such a great degree.

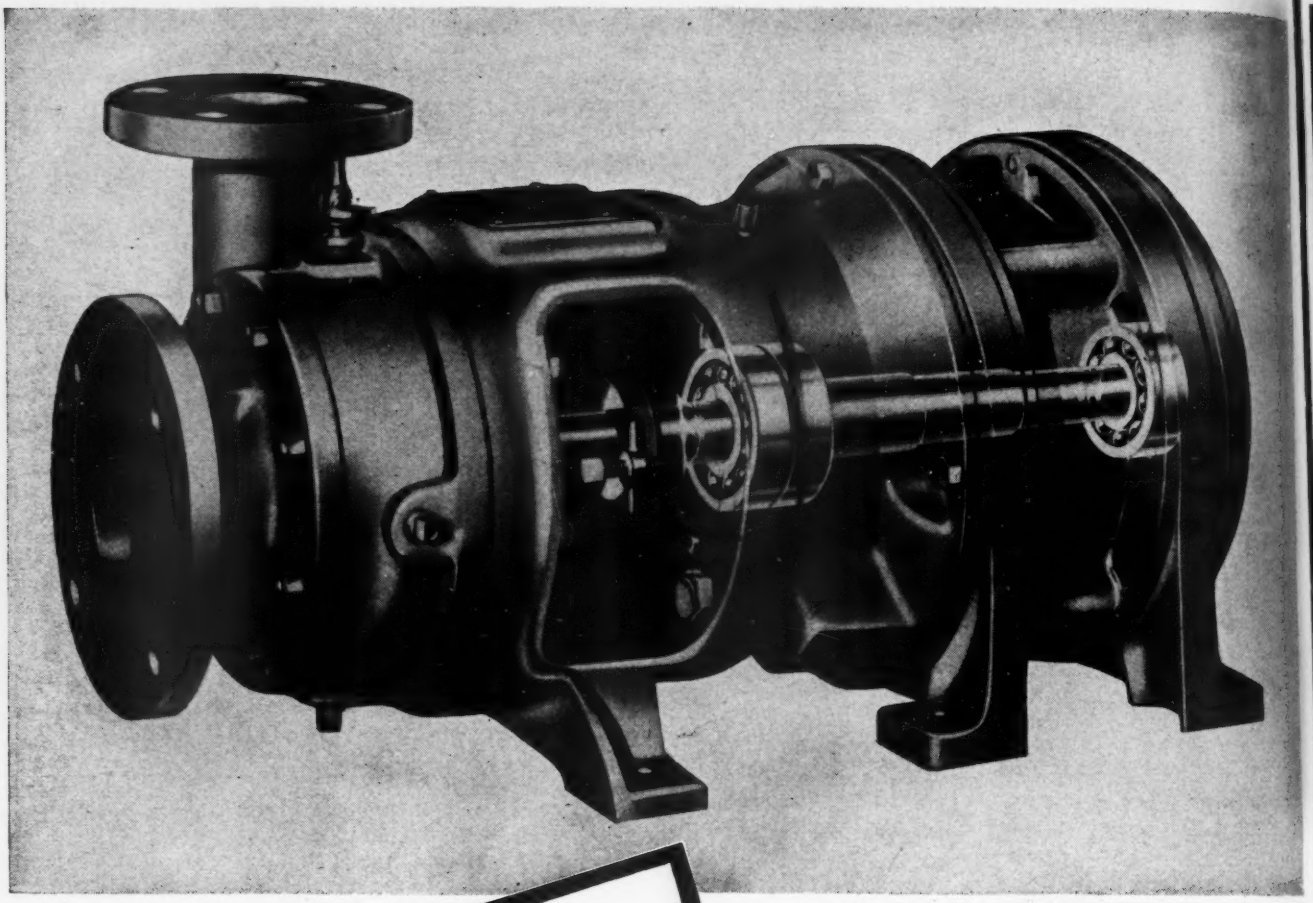


Note the cord plies made up of individual cords encased in rubber. In effect, they double the thickness of the impact cushion and because impact resistance varies as the *square* of the cushion thickness, resistance is increased *from 4 to 6 times.* Note the cord breaker running *across* the belt. That permits a spreading action that resists the cutting and gouging of heavy lumps striking the belt at the loading point. Belt life is greatly increased; ply separation practically eliminated.

B. F. Goodrich cord belts, now being made of synthetic rubber, can be used for all kinds of conveyor jobs. They are especially important for the really hard jobs that quickly ruin ordinary belts. If you have such a job in your conveyor system, ask the nearest B. F. Goodrich representative for complete information. Or write, *The B. F. Goodrich Co., Industrial Products Division, Akron, Ohio.*

B.F. Goodrich

Cord Conveyor Belts



• *SKF Bearings help to insure a smooth running unit.*

Motorpumps have rigid shafts

SKF

BALL AND ROLLER BEARINGS

The ability to stay on the job 24 hours a day over long periods is one of the first considerations when selecting bearings for Cameron Motorpumps. So is the ability to provide unusual shaft rigidity for smooth vibrationless operation and to reduce wear to a vanishing point. That SKF Angular Contact Bearings meet these requirements is the reason they are used extensively on Motorpumps with capacities ranging from 5 to 1000 gallons per minute against heads up to 240 feet single-stage and 500 feet two-stage, sizes from ¼ to 40 h.p. An SKF on the job means a Motorpump on the job . . . every time. 5532

SKF INDUSTRIES, INC. • FRONT ST. & ERIE AVE. • PHILADELPHIA 34, PA.

COOK'S METALLIC PACKINGS

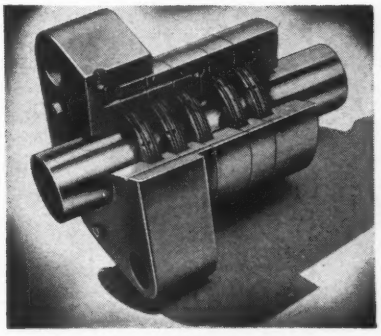
For Piston Rods of all Engines and Compressors

Engineered and built to give you more horsepower at less cost

COOK'S precision rod packings come in proved types and materials for all engines and compressors and all prevailing pressures and temperatures—packings that assure you of improved operation with minimum maintenance.

It's a combination of COOK'S basic floating ring design and precision construction which guarantees these results. For this combination assures a positive seal regardless of rod misalignment and vibration and avoids the extra friction and wear these conditions create with ordinary packings.

COOK'S Packings are original equipment in many engines and compressors. They are supplied in others on request. Make sure you get them by specifying COOK'S Packings when you order new equipment. Call or write our nearest Service Office when you want packings for equipment in service—or recommendations as to the correct packing for your particular equipment and operating conditions.



SERVICE OFFICES

Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, Montreal, New Orleans, New York, Portland, Ore., San Francisco, Seattle, Tulsa.

SEALING PRESSURES

SINCE 1888

C. LEE COOK MANUFACTURING CO.
INCORPORATED
LOUISVILLE, KENTUCKY

Power Men call it

PAY DIRT

If engines and compressors could digest dirt, power plant men would show even lower costs than they do.

As it is, part of the cost of repairs and parts, of fuel and oil, and of gradually lessening efficiency, must be charged directly to air that carries abrasives and other impurities into the engine.

When intake air is thoroughly and continuously cleaned, engine and compressor life is prolonged, maintenance costs go down, and efficiency stays up.

Looked at it this way, the dirt that filters *keep out* of your machine is real *pay dirt.*

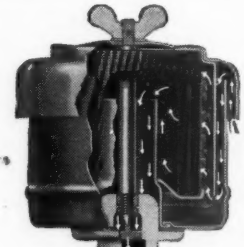
Air-Maze oil bath filters offer high efficiency for this service. Incoming air is reversed to throw out heavier particles. It is scrubbed by oil, and then passes through the viscous impingement filter media.

Oil carried by the air stream continually washes the filter element, carrying collected material to the oil sump. Pressure drop, therefore, does not increase during use, and servicing becomes merely a matter of changing oil occasionally.

Built to *last*, Air-Maze air filters are among that small group of accessories that actually pay for themselves.

Send now for your copy of the new Air-Maze general catalog, AGC-144.

EFFICIENCY STAYS UP!



Explanation:—High velocity air is first reversed, depositing heavier particles in oil. It is then scrubbed by oil, and passes through viscous impingement filter. Oil carried by air stream continuously washes filter element and renews adhesive film.

AIR-MAZE CORPORATION • ***Engineers and Manufacturers*** • **CLEVELAND 5, OHIO**

Representatives in Principal Cities • ***In Canada:*** **Williams & Wilson, Ltd., Montreal, Quebec, Toronto, Windsor**

ARMY E NAVY

AIR-MAZE

SPECIALISTS IN AIR FILTRATION

How Simplified Wire Rope Practice Benefits the Consumer

Simplified Practice for wire rope—as defined in recommendation R198-43 of the National Bureau of Standards—has been in effect since February 15, 1943. The industry has whole-heartedly accepted this reduction in sizes, grades and varieties of wire rope.

The overall reduction is from 973 items to 643, or 33.9 per cent. In the four rope constructions which represent the industry's major tonnage, the reduction is from 352 items to 182, or 48 per cent. We think that simplified practice is proving its worth.

To the consumer, there are obvious benefits in simplification. In nearly all cases he will find a rope available that fits his needs, and in addition he will get quicker deliveries and better service.

So we say to wire rope users: Stick to simplified practice ropes. We'll be glad to help you solve your problems. And, of course, simplified practice does not preclude manufacture and sale of special-purpose ropes, such as those listed in our new Wire Rope Catalogue, No. 165. Write to Bethlehem Steel Co., Bethlehem, Pa., for a copy today.

THESE ARE THE 20 STANDARD TYPES OF WIRE ROPE LISTED IN VARIOUS GRADES IN R198-43

- 6 x 7 wire rope
- 6 x 19 wire rope
- 8 x 19 wire rope
- 6 x 37 wire rope
- 6 x 19 elevator rope
- 8 x 19 elevator rope
- 5 x 19 marline clad rope
- 18 x 7 non-rotating rope
- 6 x 12 galvanized running rope and hawsers
- 6 x 24 galvanized steel mooring lines and hawsers
- 6 x 37 galvanized steel hawsers
- 6 x 25 type "B" flattened strand wire rope
- 6 x 30 type "G" flattened strand wire rope
- 6 x 8 type "D" flattened strand wire rope
- 6 x 6 x 7 tiller rope
- 6 x 7 iron, bright, and galvanized sash cords
- 9 x 4 galvanized mast arm rope
- 6 x 19 marline clad grain-shovel rope flat rope
- 6 x 7 galvanized iron rigging and guy rope

M-4 MILITARY TRACTOR — Powered by WAUKESHA ENGINE — Co-operating with the Army Ordnance Department, Allis-Chalmers Tractor Division designed and is building M-4 Military Tractors. The power plant, a Model 145-GZ Waukesha Engine, was designed and is built by Waukesha Motor Company.

NOT MEN AND MULES . . . BUT

WAUKESHA

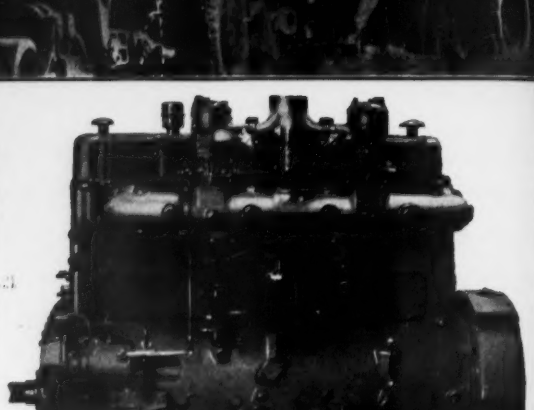
HORSEPOWER

HAULS HEAVY GUNS INTO ACTION

The motive power of men and mules that once hauled artillery isn't fast enough for this war. To get there *first* with superior fire power, our Field, Coast and Anti-aircraft Artillery must move faster . . . *and faster!*

Neither shell holes nor ditches, muck, mud nor mountains stop the new track-laying M-4 Military Tractors from moving the heaviest guns into position. Powered with Model 145-GZ Waukesha Engines, they have all the pulling power of a track-type tractor plus the smooth eager speed of a truck.

This is a wartime Waukesha Engine . . . a special development for combat service in heavy ordnance equipment . . . a super power plant built by Waukesha to out-power and out-perform any similar engine of the same size ever produced!



MODEL 145-GZ WAUKESHA ENGINE

Six cylinders, 5⅜ in. bore x 6 in. stroke, 817 cu. in. displ. Burns gasoline . . . is designed to use modern aviation fuels . . . develops high output. And it's really rugged! Crankcase and cylinder block cast as a single unit. Crankshaft is drop-forged steel, heat treated. Wet sleeve cylinders easy to remove and replace. Positive pressure oiling. Thermostatic by-pass system guards against over-cooling, assures quick warm-up when starting.

Right now all Waukesha production is for war work. After the war is won, peacetime Waukesha Engines will be ready for all your special requirements. Consult Waukesha engineers now about your future engine needs.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.

NEW YORK • TULSA • LOS ANGELES

MORE POWER FOR VICTORY

WAUKESHA ENGINES

Because a Jackhamer strikes 2,000 hard blows a minute . . .

SHELL CLAVA OIL KEEPS AIR TOOLS "ON THE GO"

1. Its great film strength assures protection for all moving parts under the most severe operating conditions.
2. Flows freely through the lubricating system at all temperature ranges encountered.
3. Has high wetting ability . . . protects internal drill parts against rust.
4. Does not form "gum," keeps valve action free. Seals pistons effectively.
5. Adheres to metal surfaces, making it possible for a small quantity of oil to do a complete lubrication job over long operating periods.
6. Carbon formation is reduced to a minimum.

NOTE: *To assure adequate lubrication at all times the use of an air-line lubricator is recommended.*

A "LAZY" OIL WON'T DO!

IN order to give trouble-free performance, an air-drill lubricant must do more than just lubricate. It must have all of the characteristics listed in the box at left. Any oil that does less is a "lazy" oil . . . causes costly production delays.

Shell Clava Oil has *all* of the characteristics necessary for reliable air tool performance. That's why operators have found that by using hard-working Shell Clava Oil, air tools stay "on the job" for longer periods of time, prevent excess wear of parts.

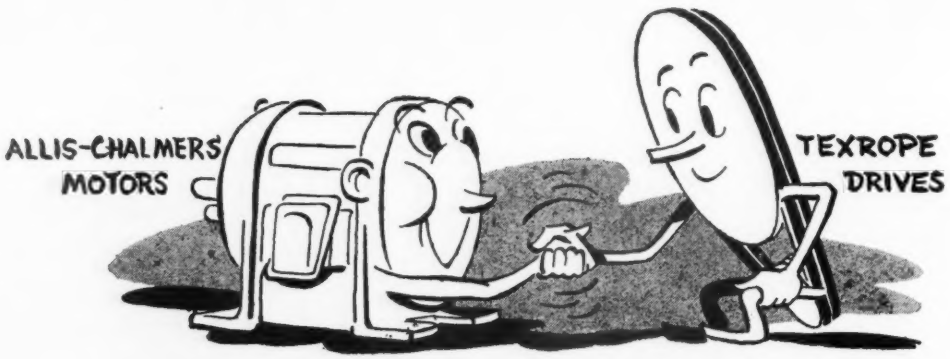
Call in the Shell man now. Let him show you how your air tools will serve you with utmost dependability when lubricated with Shell Clava Oil.

SHELL *COMPRESSED AIR* LUBRICANTS

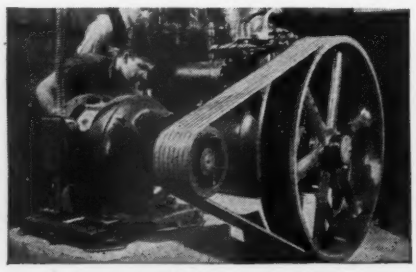
COMPRESSA OIL FOR AIR COMPRESSORS

CLAVA OIL FOR AIR TOOLS

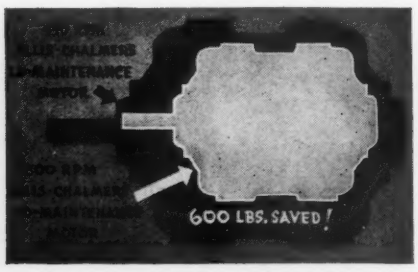
A-C "Team" Flexibility



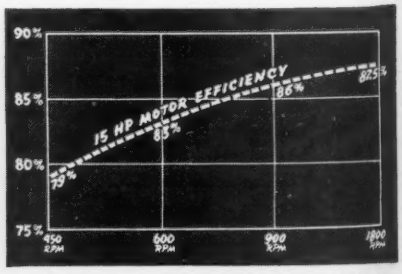
★ To drive low speed machinery with high speed motors (now that low speed motors are sharply restricted), Allis-Chalmers Texrope Drives can "gear down" motor speeds over a range of 7 to 1. As America's only builder of *both* motors and V-belt drives, Allis-Chalmers has long studied and advocated their use in proper com-



1 In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor —at lower cost in money *and materials!*



2 When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb are saved. And *you* save well over $200 — with drive figured in!



3 Note that efficiency rises from 79% for the 450 rpm motor to 87.5% for the 1800 rpm motor. The 1800 rpm motor saves you over 30 kw/24 hr. day.

WE WORK FOR VICTORY — WE PLAN FOR PEACE

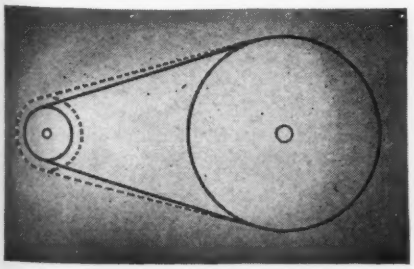
ALLIS-C

Gives You now needed

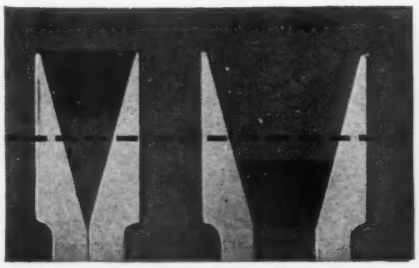
bination . . . today offers you the benefit of long pioneering experience. Texrope Drives are compact, highly efficient, protect your equipment by absorbing shock.

★ To drive a machine at different rates with a single speed motor (now that multi-speed motors are sharply restricted), Texrope Adjustable-Speed Drives give you infinite speed range up to 375%. And in Allis-Chalmers full line of Texrope Drive equipment you'll find the *right* range for your machines . . . thus avoid paying extra for more speed than you need. For engineering cooperation, feel free to call on your nearby Allis-Chalmers district office or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

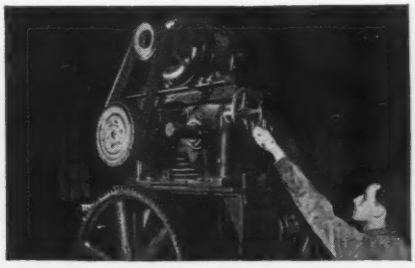
A 1706



4 Infrequently needed speed changes can be had by changing from one size motor sheave to another. Juggling *complete* drives, range is 1:1 to 7:1.



5 With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter . . . obtaining an *unbroken* series of speeds!



6 Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's compact, flexible, *efficient!*

ALLIS-CHALMERS

LO-MAINTENANCE MOTORS
TEXROPE DRIVES

IT TAKES JUST SIX STURDY PARTS TO MAKE A STRONG *Walco* WRENCH

Each of the six parts that make up a Walco wrench is designed to provide maximum strength, safety, and ease of operation. ***All parts are made entirely of steel.*** Handle and both jaws are drop forged steel, heat treated by precision methods to assure strength, toughness and uniformity.

Each part is replaceable including the exclusive Walco renewable lower jaw. This makes the Walco easy to maintain and good for an indefinite span of service—no matter how severe the service or how heavy the abuse.

Thousands of users prefer the Walco as the safest, strongest, most useful pipe wrench made. The Walco wrench is a product of the Walworth Company, manufacturers of valves, fittings and tools for over a century.

The Walco wrench is made in lengths of 6"—8"—10"—14"—18"—24"—36"—and 48". The 6" and 8" sizes have integral lower jaw.

ARMY E ARMY E NAVY

BOSTON WORKS
KEWANEE WORKS

WALWORTH
valves AND fittings

WALWORTH ★ VALVES AND FITTINGS ★ ESTABLISHED 1842

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Construction Crews are Not "Expendable"

These reminders of safe excavator operation may save you serious time-losses and help to keep your men working 100 per cent on the job for victory:

Replace ropes as soon as they show broken strands. A few shifts of extra rope service is not worth a serious accident.

Set dipper or bucket solidly on the ground when leaving the machine—never suspended in the air. By doing this there's no danger that a cooling brake or a creeping drum will pin a man under the load.

Always disengage engine clutch when engine is stopped and whenever operator leaves his seat. Do not engage engine clutch till after engine is started.

Always watch dipper, bucket, or load while it is moving. If you must look away, stop hoist and swing motions. Accurate control adjustments are essential to safety.

Keep eyes peeled for cave-ins; swing machine clear; if necessary, back it out of danger.

Teach pitmen alertness at all times. A rolling stone can maim or kill as well as a bullet.

During blasting operations, turn rear end of excavator toward the blast, moving machine to as safe a position as possible. In an emergency the dipper, set back on the pit floor, makes the safest shelter from blast fragments.

Safety first, last and all the time is a "must" for everyone on the job. Uncle Sam needs every possible man-hour on the production front; each time-loss is a victory for the Axis.

Bucyrus-Erie

SOUTH MILWAUKEE, WISCONSIN, U. S. A.

THE MOST DEPENDABLE METHOD OF LUBRICATION EVER DEVELOPED

MODEL OL
ROTARY DRIVE

MADISON-KIPP

Fresh Oil LUBRICATORS

Fresh Oil FED UNDER PRESSURE BY THE MEASURED DROP

There are Madison-Kipp lubricator models for every Fresh Oil application. There are 6 models and each can be varied to suit the requirements in drive type and location, in the number of feed outlets, rate of feed and pumping pressure. Madison-Kipp specializes in original standard equipment lubricators. When you buy new machinery it will pay you to specify Madison-Kipp . . . the most dependable method of lubrication ever developed.

MADISON-KIPP CORPORATION, 202 Waubesa St., Madison 4, Wis., U. S. A.

Sole Agent in England: Wm. Coulthard & Co., Ltd., Carlisle

Make AO YOUR Arsenal for ALL Your Eye Protection Needs

Protecting workers' eyes from industrial hazards calls for systematic study, careful analysis, long-term planning. No matter how competent you are to set up and carry on an eye protection program in your plant, AO can bring you additional constructive help, valuable cooperation.

We invite you to take full advantage of our facilities. Call for the services of a trained AO Safety Engineer. Ask to have a survey made of your plant to uncover *every* eye hazard. Make use of AO posters, unique eye protection charts, and safety literature. Keep a complete AO Safety Equipment Catalog at hand. Depend on rapid, efficient service from a nearby AO branch office. Select the goggles you need from the *complete* AO line—each type scientifically designed for lightest weight and greatest comfort consistent with maximum protection. Get acquainted with an AO Safety Representative—he can help you in your fight against eye accidents.

American AO Optical

COMPANY

SOUTHBRIDGE, MASSACHUSETTS

ON A PRESSURE VESSEL...

In a pressure vessel, especially a very large one like that shown above, quality of construction is influenced to a considerable degree by the facilities of the manufacturer and the skill of the men who do the work. It is in these two respects that Combustion Engineering shops in Chattanooga and St. Louis stand out.

A long range modernization plan, started in 1935 and tremendously expanded to meet the demands of our nation at war, accounts for the exceptional diversity and extensiveness of C-E's present manufacturing facilities. C-E's experience in the field dates back more than fifty years, includes pioneer development work in fusion-welded fabrication and X-ray examination of welded seams and, at the same time, incorporates first hand information on every modern improvement in fabricating methods.

C-E Shops are prepared to produce, in accordance with your design and specifications, all types of pressure vessels of carbon, alloy or clad steels. We believe that we are particularly well qualified to be of service on difficult fabricating problems and solicit your inquiries.

A-553-A

COMBUSTION C-E ENGINEERING

200 Madison Avenue, New York, N. Y.

C-E pressure vessels are produced at the following plants:

HEDGES-WALSH-WEIDNER DIVISION
Chattanooga, Tenn.

HEINE BOILER DIVISION
St. Louis, Mo.

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS & STOKERS; ALSO SUPERHEATERS, ECONOMIZERS & AIR HEATERS

EVEN TIGER BRAND NEEDS IT!

Add life to your wire ropes with LUBRICATION

One of the most frequent causes of premature wire rope failure is lack of proper lubrication. Yet lubrication is such a simple means of extending rope life that it seems incredible that rope users should overlook it. But they do.

Every American Tiger Brand Wire Rope comes to you from the factory, properly lubricated and ready for service. But factory lubrication, no matter how efficient, will not last the life of the rope. Field lubrication at regular intervals is absolutely essential. Wire rope is a machine, composed of many working parts. It requires periodic lubrication to reduce frictional wear.

Use a well-tested lubricant like Tiger-Lube which has been developed through years of study and research. Be sure that the rope surface is clean and that the lubricant is applied uniformly and thoroughly.

Lubrication is insurance against corrosion and is the safest way to prevent excessive internal and external rope wear. Lubrication will materially assist in controlling the wear on sheaves and drums and in prolonging rope life, resulting in increased operating efficiency.

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York

COLUMBIA STEEL COMPANY
San Francisco

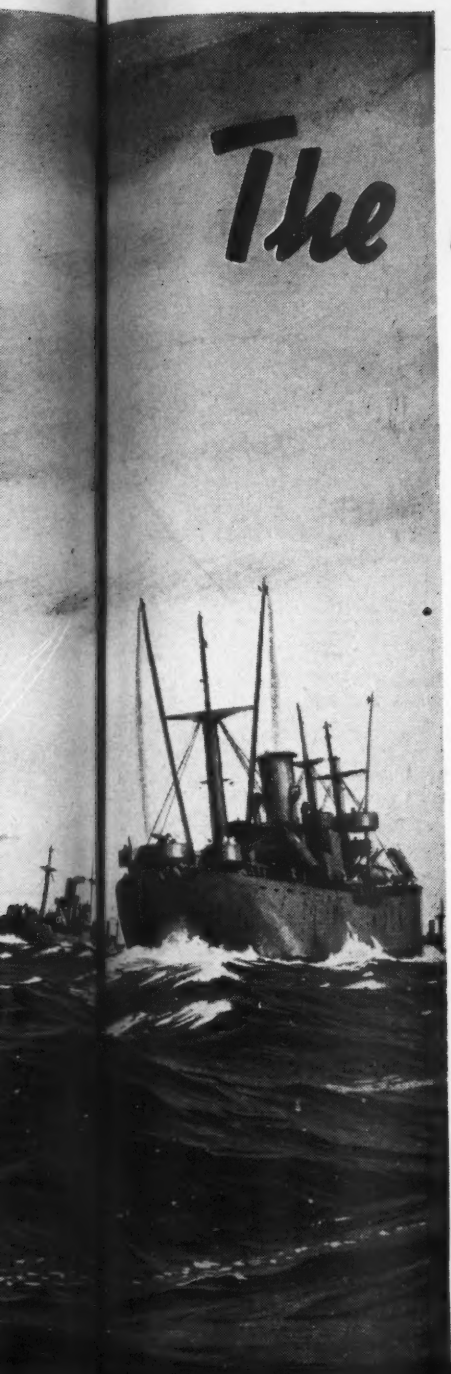
United States Steel Export Company, New York

USS

Excellay Preformed

UNITED STATES STEEL

Ingersoll-Rand
Ingersoll-Rand



The Bridge of Ships

Delayed by head winds, blown off course by storms, stalled by calms, the tiny ships of Columbus completed what was then a most hazardous crossing. Today the hazards of weather and warfare have been conquered and an endless, steadily moving procession—a bridge of ships—transports millions of men and vast quantities of materiel to our far-flung battlefronts.

Each of these ships must have a complete, self-contained power plant for propulsion, heating, lighting, and communication. Ingersoll-Rand is playing an important part in building and equipping this bridge of ships. It furnishes centrifugal pumps, air compressors, Diesel engines, surface condensers, vacuum equipment and refrigeration units for vessels of many types. Furthermore, its air compressors and air-operated tools, such as riveters, impact wrenches, chippers, grinders and hoists are standard equipment in shipyards everywhere.

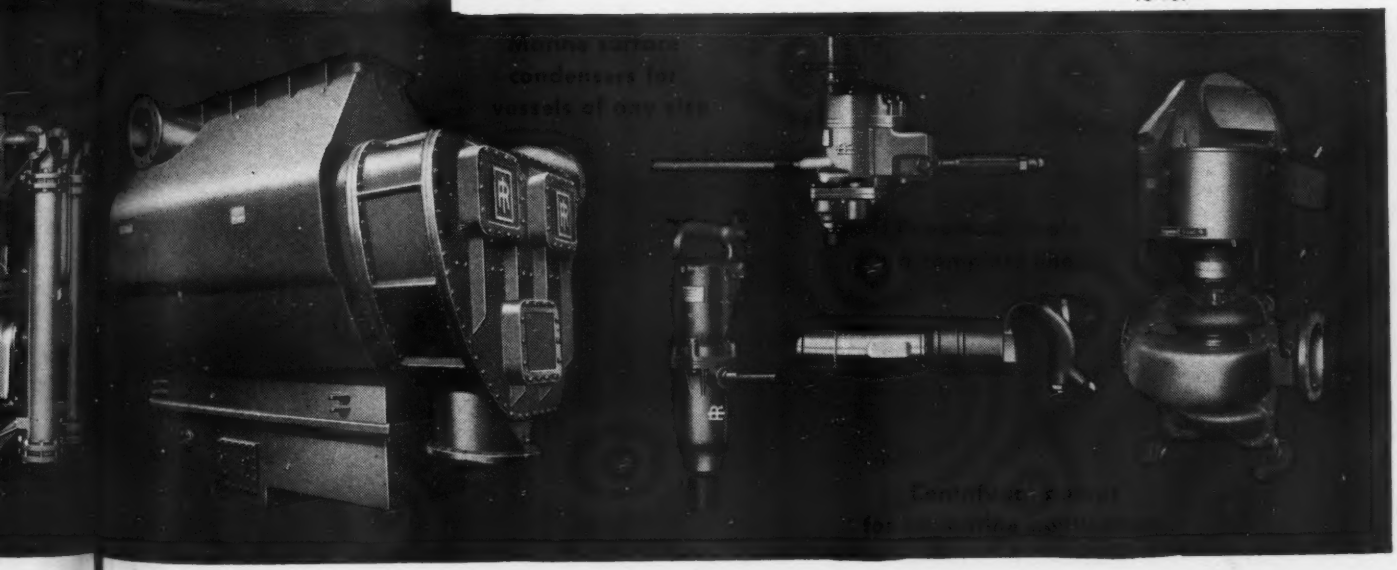
Since the days of the iron-clad steamship "U.S.S. Dunderberg" in 1866, the names Ingersoll-Rand and Cameron, a division of Ingersoll-Rand, have been associated with the shipbuilding industry—have stood for progress and dependability in equipment peculiar to this most exacting service.

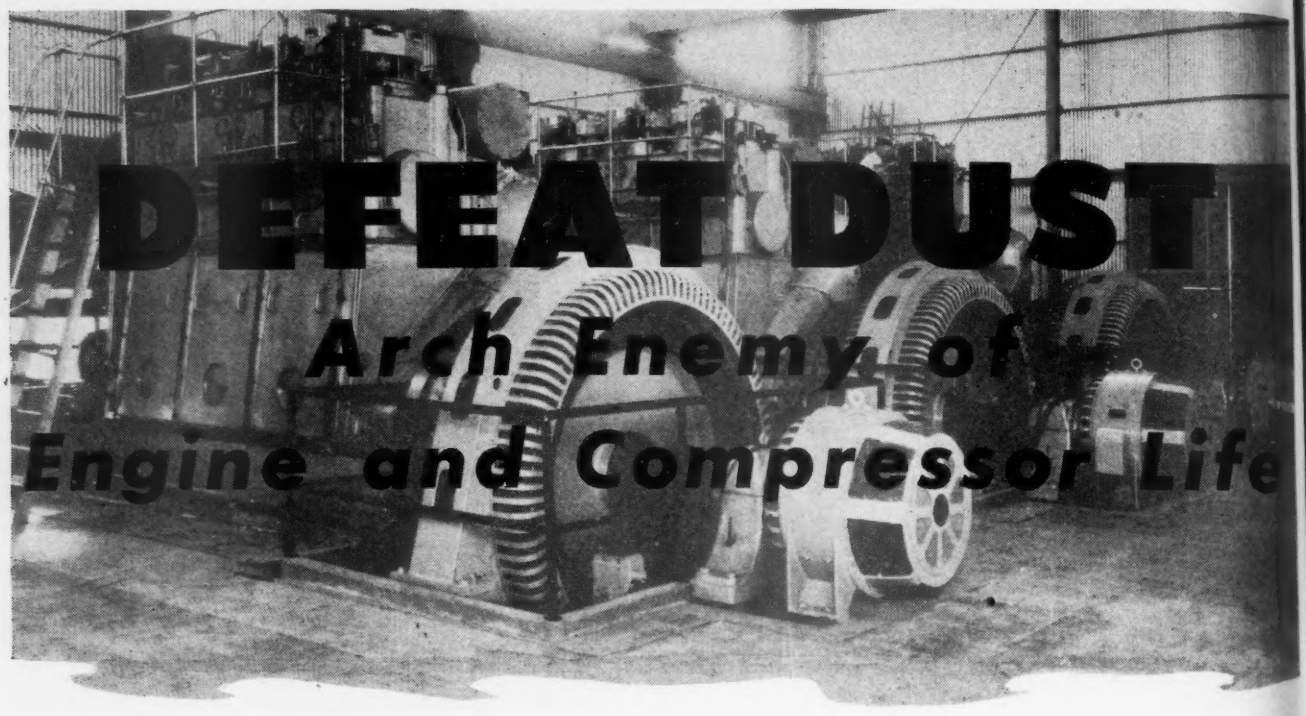
Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS
OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

10-369





DEFEAT DUST

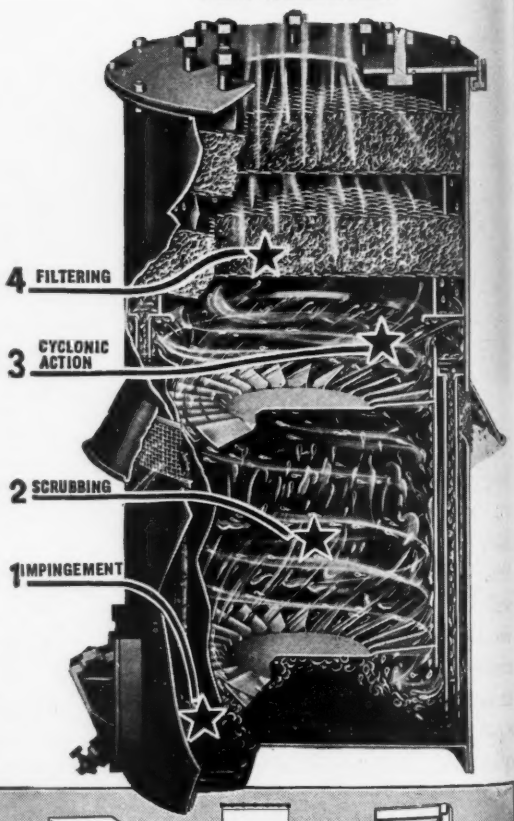
Arch Enemy of Engine and Compressor Life

WHEN you protect power equipment with AAF air cleaners you prevent the unnecessary costly, time-consuming breakdowns which always result from excessive wear caused by abrasive dust and grit that attacks the vitals of your engines and compressors.

Throughout the nation, Cycoil cleaners are prolonging the useful life of valuable power equipment—permitting uninterrupted operation on stepped-up running time and accelerated production schedules.

The cost of Cycoil's "preventive maintenance" is insignificant compared to savings in wear, running time and man-hours. Send for facts on the Cycoil and other AAF engine and compressor filters for every air and gas cleaning requirement.

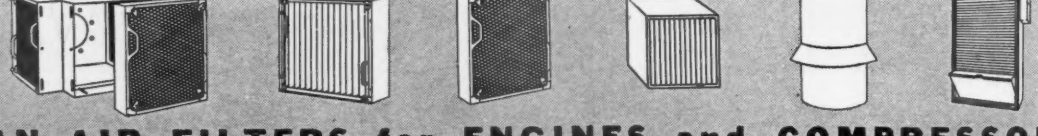
THE CYCOIL OIL BATH AIR CLEANER



The fundamental advantage of the Cycoil Oil Bath cleaner is that the incoming air stream picks up an unusually large quantity of oil which is thoroughly mixed with the air (causing a scrubbing or precleaning action), and then thrown out by centrifugal action before the air stream enters the filter cell. This results in reducing the dust load on the filter cell and insuring continued self-cleaning action.

AMERICAN AIR FILTER CO. INC.
402 Central Avenue, Louisville, Kentucky
In Canada: Darling Bros., Ltd., Montreal, P. Q.

AAF

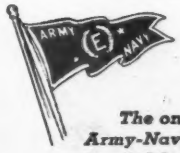


AMERICAN AIR FILTERS for ENGINES and COMPRESSORS

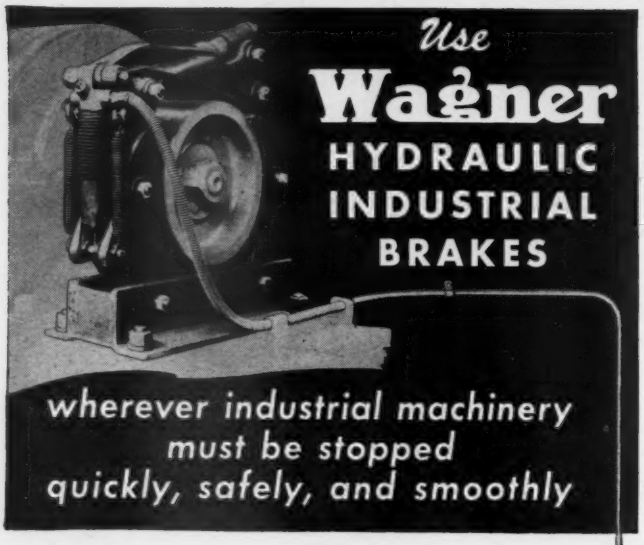
The new engine you've been hearing about, that will work miracles in performance and economy, hasn't just been waiting the end of the war. It has been waiting development of a piston ring that would stand the tremendously increased mean effective pressures involved, and give the improved anti-scuffing and long wearing qualities required.

In the finest, largest and best-equipped ring research laboratory in the country, American Hammered engineers have worked day and night on the problem . . . and as usual have come up with the answer. Within the past six months they have developed rings having DOUBLE any previous strength. With the PORUS-KROME* treatment, these rings will let engine builders design far ahead of past possibilities. Koppers Company, American Hammered Piston Ring Division, Baltimore, Md.

* (Van der Horst Process)



The only Army-Navy "E" awarded for piston ring production



Use Wagner HYDRAULIC INDUSTRIAL BRAKES

wherever industrial machinery must be stopped quickly, safely, and smoothly

While the principal application for Wagner hydraulic industrial brakes is for overhead traveling cranes, there are many other applications for which they can be efficiently used.

Some of these applications are bending rolls, scrap balers, large wheel balancers, and similiar applications when it is desirable to decelerate the machine by foot pressure for either normal or emergency stops.

Available in Complete Systems

Wagner hydraulic industrial brakes come to you complete, all ready to install. The complete system includes brake assembly, brake wheel, master cylinder, wheel cylinder, tubing, flexible hose, brake fluid, and all fittings.

● Brake wheel—furnished as specified to meet application

● Brake assembly —Type H illustrated

REPLACEMENT BRAKE LINING
For any industrial brake

● Non-scoring

● Reinforced wire backing permits deep seating of bolts or rivets

Wagner molded brake lining is preformed in blocks to meet the requirements for all industrial brakes.

Send for Bulletins IU-20 *and* BU-145

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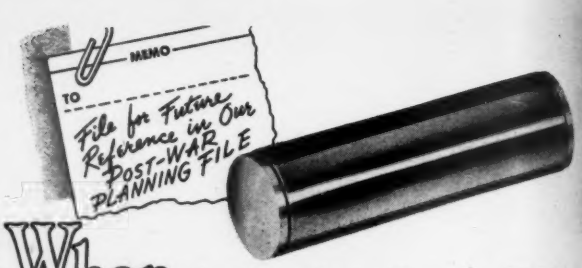
Wagner Electric Corporation
ESTABLISHED 1891
6418 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS



When *the War Story Can Be Told...*

about Burgess-Norton's production achievements and developments in the manufacture of . . . . .

PISTON PINS

of all types including aircraft with finishes to 2 micro inches . . . in the field of

HYDROGEN COPPER BRAZING

where with the largest and latest type "*controlled atmosphere*" electric furnaces, copper brazed and heat-treated parts are being mass produced in one continuous operation . . . in the field of

HEAT TREATED, SCREW MACHINE AND GROUND STEEL PARTS...NON-PRECISION BALL BEARINGS

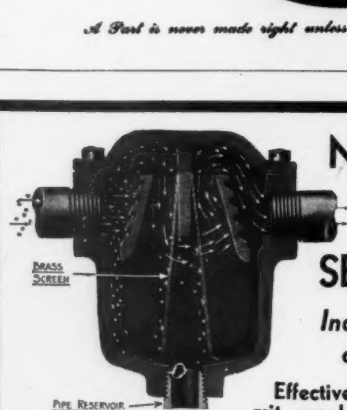
where highest production rates are being achieved without sacrifice of quality uniformity . . .

. . . . you will discover much that will be to your advantage in post-war production.

1 of 7 Chicago Ordnance District winners of the Second Star for continued high production of war materials.

Burgess Norton
MANUFACTURING COMPANY
40 years in GENEVA, ILLINOIS

A Part is never made right unless it is satisfactory to our customer.



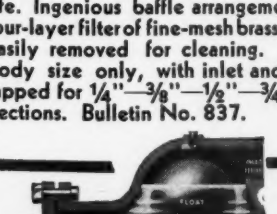
NICHOLSON AIR SEPARATORS

Increase the Efficiency of Pneumatic Tools

EASILY INSTALLED
EASILY CLEANED

Effectively remove moisture, oil and grit, supplying clean, dry air to pneumatic tools, greatly prolonging their life. Ingenious baffle arrangement and four-layer filter of fine-mesh brass screen, easily removed for cleaning. One body size only, with inlet and outlet tapped for ¼"—⅜"—½"—¾" connections. Bulletin No. 837.

Keep Air Systems Drained with a
NICHOLSON COMPRESSED AIR TRAP



Model "JR"—Provides long trouble-free service. For pressures to 200 lbs. Intermittent discharge, welded stainless steel float, water-sealed discharge valve.

Bulletin No. 341

W. H. NICHOLSON & CO.
180 OREGON ST., WILKES-BARRE, PA.
Valves ★ Traps ★ Steam Specialties

STRENGTH

FOR SAFETY AND LONG-TIME SERVICE

Specify

Vogt

DROP FORGED STEEL FITTINGS

SCREW END TYPE

For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SOCKET WELD TYPE

For schedules 40, 80 and 160 pipe — Sizes 1/8" to 6"

Round-the-clock operation of oil refineries, chemical plants, steam plants, etc., essential to the continuous flow of war products to the United Nations, is all in the day's work for these fittings. Today, as in peacetime, Vogt drop forged steel fittings make a major contribution to the efficient functioning of pipe lines in plants vital to the war effort.

Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy.

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

HENRY VOGT MACHINE CO., Inc., LOUISVILLE 10, KY.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

ATLAS STEEL CASTING COMPANY

OPEN HEARTH & ELECTRIC STEEL

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NEW YORK OFFICE
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Secretary

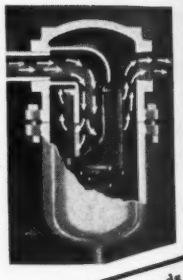
MAKES *Compressed Air* COME CLEAN

THE JOHNSON GAST *2-way* SEPARATOR

WATER, dirt and oil in compressed air lines can be a big source of trouble and expense—causing imperfect results, and deteriorating air hoses and equipment rapidly.

The Johnson-Gast Separator is the simplest way to make your compressed air come clean. It takes out more than 99% of all troublesome foreign elements, because it employs *both* of the accepted principles of separation—expansion and change of direction. The illustration shows its simple, sturdy construction. It can be used with equal efficiency on steam lines also.

When moisture in the air is vaporized by heat generated during compression, the Johnson-Gast Aftercooler is used to condense all vapor so the Separator can remove it. Where every final trace of oil must be removed—as in paint spraying—the Johnson-Gast Oil Absorber is also used.



1. Air first expands, precipitating most of moisture.
2. "Thousand Baffles," labyrinth of wire mesh, changes flow direction — captures remaining water and dirt.

•

Write for bulletin showing sizes and capacities of the complete Johnson-Gast line of separating devices.

THE JOHNSON CORPORATION
830 Wood Street, Three Rivers, Mich.

JOHNSON-GAST
SEPARATORS • AFTERCOOLERS • OIL ABSORBERS

NIAGARA *AERO* AFTER-COOLER
U. S. Patent Nos. 2,321,933 and 2,296,946
Other Patents Pending

Keeping Water and Oil Out of COMPRESSED AIR

● Controlled temperature cooling with the NIAGARA *AERO* AFTER-COOLER has been the answer to excess water and oil in compressed air lines, preventing spoilage of material when compressed air is used in process and preventing damage to pneumatic tools. No refrigeration is required.

The NIAGARA *AERO* AFTER-COOLER both condenses the moisture before it gets into the lines and also provides jacket water of the proper temperature to prevent condensation in the compressor, washing out the lubricating oil.

It helps produce compressed air containing only ½ to ¾ as much moisture as air cooled by conventional equipment. At the same time it saves 95% of the cost of cooling water, pays for itself in a short time. Write for complete information.

NIAGARA BLOWER COMPANY
"25 Years of Service in Air Engineering"
NEW YORK ADDRESS: Dept. CA-44
6 E. 45th Street, New York-17, N. Y.
Field Engineering Offices in Principal Cities

NIAGARA *INDUSTRIAL* COOLING • HEATING • DRYING
HUMIDIFYING • AIR ENGINEERING *EQUIPMENT*

2 pictures of a champion!

In mines, in engineering projects large and small, the detachable bit is proving itself to be a champion miner! Above you see two views of a detachable bit. The left hand picture shows one that has lost its cutting edge. The other shows it ready for service again.

When detachable bits are used, the work speeds up and drilling costs go down. In the first place, time and labor are saved because you don't have to take steel in and out of working places. In the second place all that is needed to keep detachable bits in shape is a simple forming and gauging operation.

To get the best results with detachable bits choose a grinding wheel that cuts free and cool, preserving the temper of the steel. Recommended for this work is the *Aloxite* Wheel by Carborundum. For service call our nearest sales office. The Carborundum Company, Niagara Falls, New York.

CARBORUNDUM
TRADE MARK
ABRASIVE PRODUCTS

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh, Cincinnati, Grand Rapids.

Power Feed Drifter using detachable bits on a big tunnel job.

Grinding Wheels by CARBORUNDUM
TRADE MARK

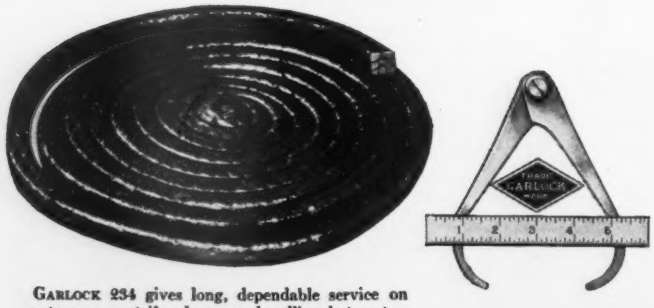
(Carborundum and Aloxite are registered trade marks of and indicate manufacture by The Carborundum Company)

Garlock Products

Help Keep Things Moving!

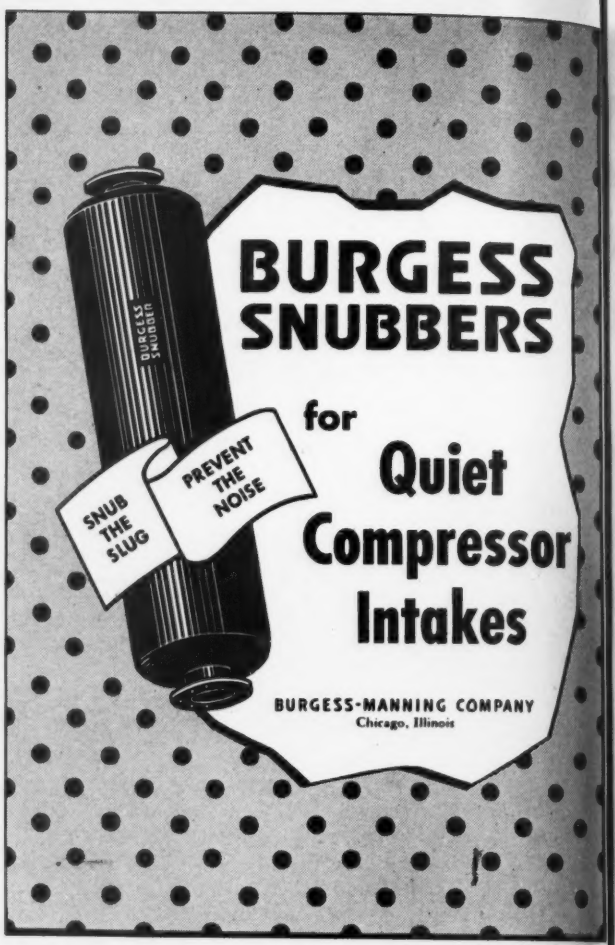
GARLOCK packings, gaskets and KLOZURE oil seals play a vital role in war plants throughout America . . . and in U. S. warships, planes and tanks throughout the world. Our Armed Forces as well as our industries *rely* on the *dependable performance* of GARLOCK products to keep things moving *fast*—for Victory.

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.
In Canada: The Garlock Packing Company of Canada, Ltd., Montreal, Que.



GARLOCK 234 gives long, dependable service on rotary or centrifugal pumps handling hot water, cold water, caustic solutions or weak acids. All sizes from 1/8" to 1 1/4".

GARLOCK

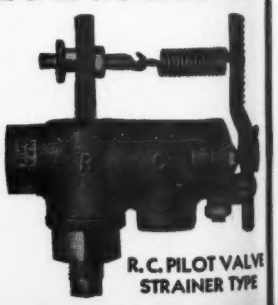


BURGESS SNUBBERS for Quiet Compressor Intakes

BURGESS-MANNING COMPANY
Chicago, Illinois

R. C. PILOT VALVES FOR POSITIVE CONTROL

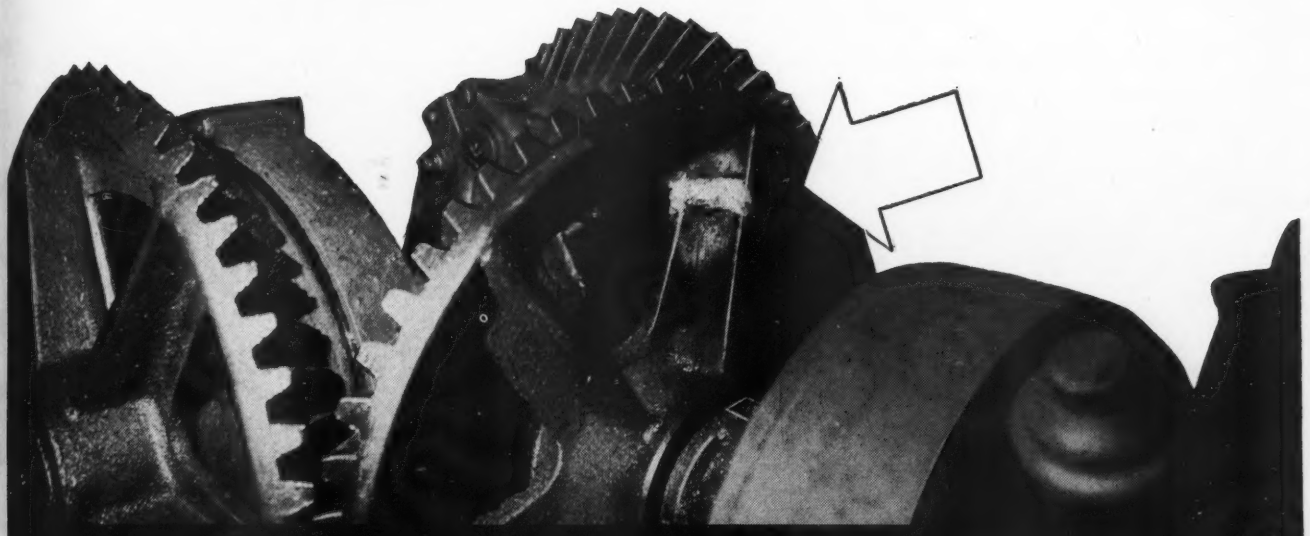
R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R. C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

Hours for repair SAVE Weeks for replacement



Anaconda "997" repair weld saves sheet production at National Lead Company

A CRACKED SPOKE in one of the main drive gears of the 97" reversing sheet rolling mill at the National Lead Company Plant in Cleveland, Ohio threatened vital war production. It looked like weeks of downtime while a replacement gear made the tedious journey through pattern shop, foundry and machine shop.

But, in a matter of hours the mill was rolling again. A repair weld was made by the Neal Welding Company of Cleveland with Anaconda 997 Low-Fuming Rod, and without dismantling the machine.

Thanks to Anaconda Welding Rods and Tobin Bronze*, "Don't scrap it... *weld* it!" has become a war production slogan in industrial plants from coast to coast. Remember that before you call the junk man. 4487

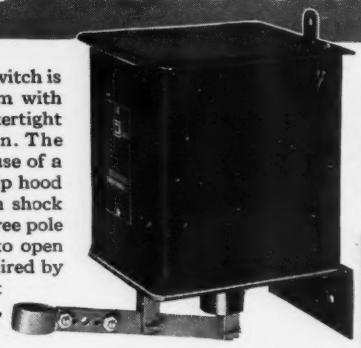
*Reg. U. S. Pat. Off.

THE AMERICAN BRASS COMPANY
Subsidiary of Anaconda Copper Mining Company
General Offices: Waterbury 88, Connecticut
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA *Anaconda Welding Rods*

Marine FLOAT SWITCH

DRIPPROOF AND WATERTIGHT
HIGH SHOCK CONTACT BLOCK
TWO OR THREE POLE
CLASS 9036 • TYPE AW-H



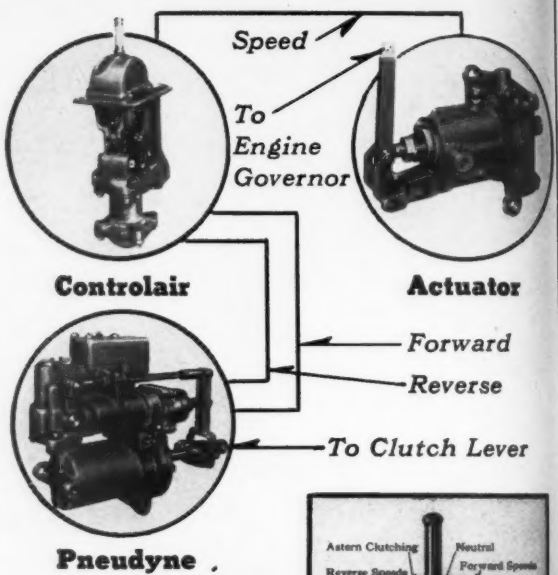
● The class 9036 type AW-H float switch is built for Marine Service to conform with requirements for a dripproof and watertight device of shockproof construction. The switch differs from standard in the use of a special sheet steel enclosure and drip hood with gasket seal and a special high shock bakelite contact block of two or three pole form. The switch can be arranged to open or close on rise in liquid level as required by application. Mounting is three point by means of bracket flange and foot, as illustrated. **Write for Bulletin 563.**

ELECTRICAL RATINGS

Voltage	Single Phase A. C.	Polyphase A. C.	D.C.
110V.	2 H.P.	3 H.P.	1 H.P.
220V.	3 H.P.	5 H.P.	1 H.P.
440-550	5 H.P.	5 H.P.	.....
32V.	.....	.....	½ H.P.

REGULATOR DIVISION
SQUARE D COMPANY
DETROIT • MICHIGAN

W•A•B PNEUMATIC CONTROL SYSTEMS *for* DIESEL ENGINES

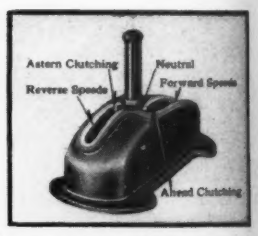


W•A•B Pneumatic Control Systems are winning new advocates through their superb performance of functions from a remote control station.

On non-reversing Diesel engines, clutch shifting and engine speed are controlled from a single lever. A Pneudyne, on the housing of the directional clutch, shifts the clutch lever, and an Actuator on the engine positions the speed lever of the engine governor as directed by the lever position of the Controlair at the control station.

Multiple engines are controlled from multiple control levers. Dual control stations may be used, with control transfer from station to station. Multiple engines driving the same power shaft are synchronized to balance the engine load.

On direct reversing engines, pneumatic controls are super-imposed on the existing manual controls or built into the engine design.

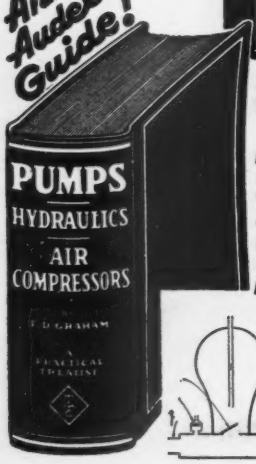


Position Diagram of Controlair

WESTINGHOUSE AIR BRAKE CO.

INDUSTRIAL DIVISION - WILMERDING, PA.

An Audel Guide!



PUMPS-HYDRAULICS-AIR COMPRESSORS

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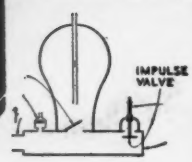

***PART 3*—AIR COMPRESSORS—406 Pages:** Compression of Air—Compressor Classification—Parts, Types—Inter and After Coolers—Regulating Devices—Installation—Lubrication—Operation—Maintenance—Blowers—Super-Chargers—Pneumatic Hand Tools—Ready Reference Index and Tables. 402 Illustrations.

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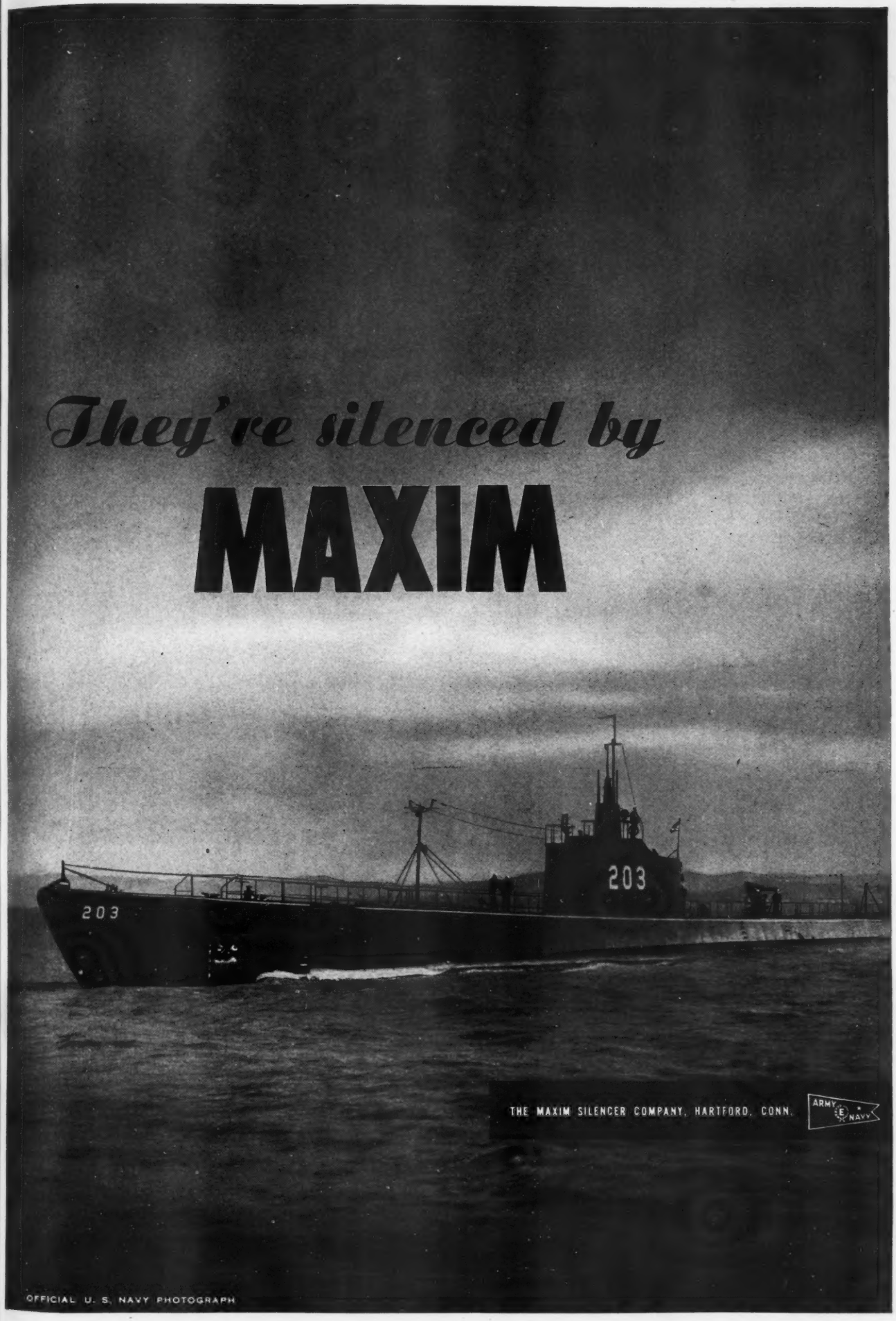
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THE MAXIM SILENCER COMPANY, HARTFORD, CONN.
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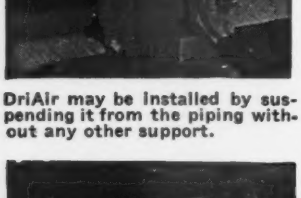
DEPENDABLE PNEUMATIC SERVICE

WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir may be installed by suspending it from the piping without any other support.



A typical installation showing DriAir standing on the floor next to the wall.

The answer to many problems which arise in various applications of compressed air, DriAir speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request; write today.

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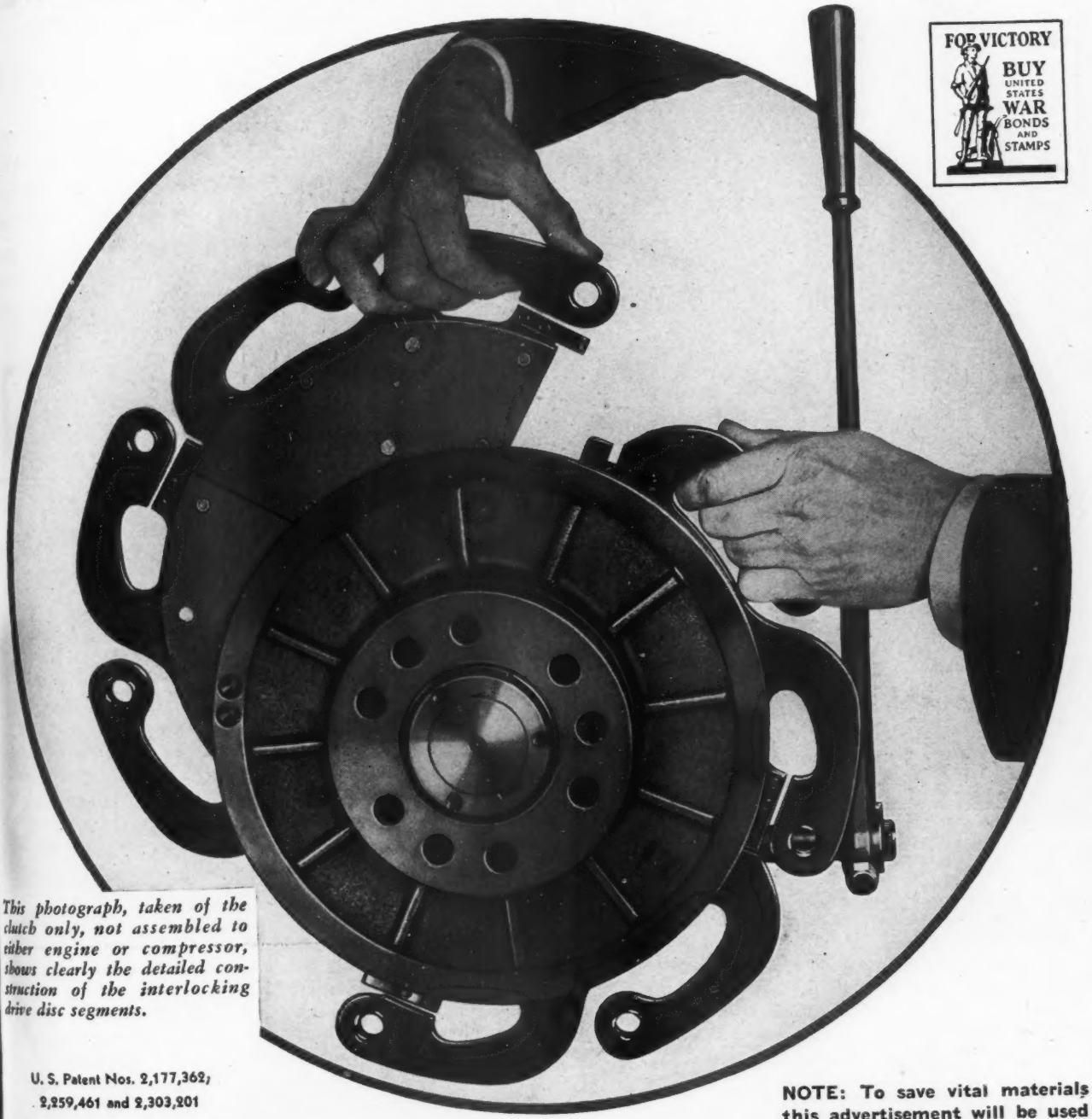

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

This photograph, taken of the clutch only, not assembled to either engine or compressor, shows clearly the detailed construction of the interlocking drive disc segments.

U. S. Patent Nos. 2,177,362; 2,259,461 and 2,303,201

NOTE: To save vital materials this advertisement will be used for "the duration."

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The swelling chorus has reached an ear-splitting tune and America's song of victory fills the air . . . the air that gives life to the earth and its people . . . the same air that furnishes an inexhaustible medium of power transmission for one of the chief weapons of industry, *the compressed air operated tool.*

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TIMKEN BEARINGS
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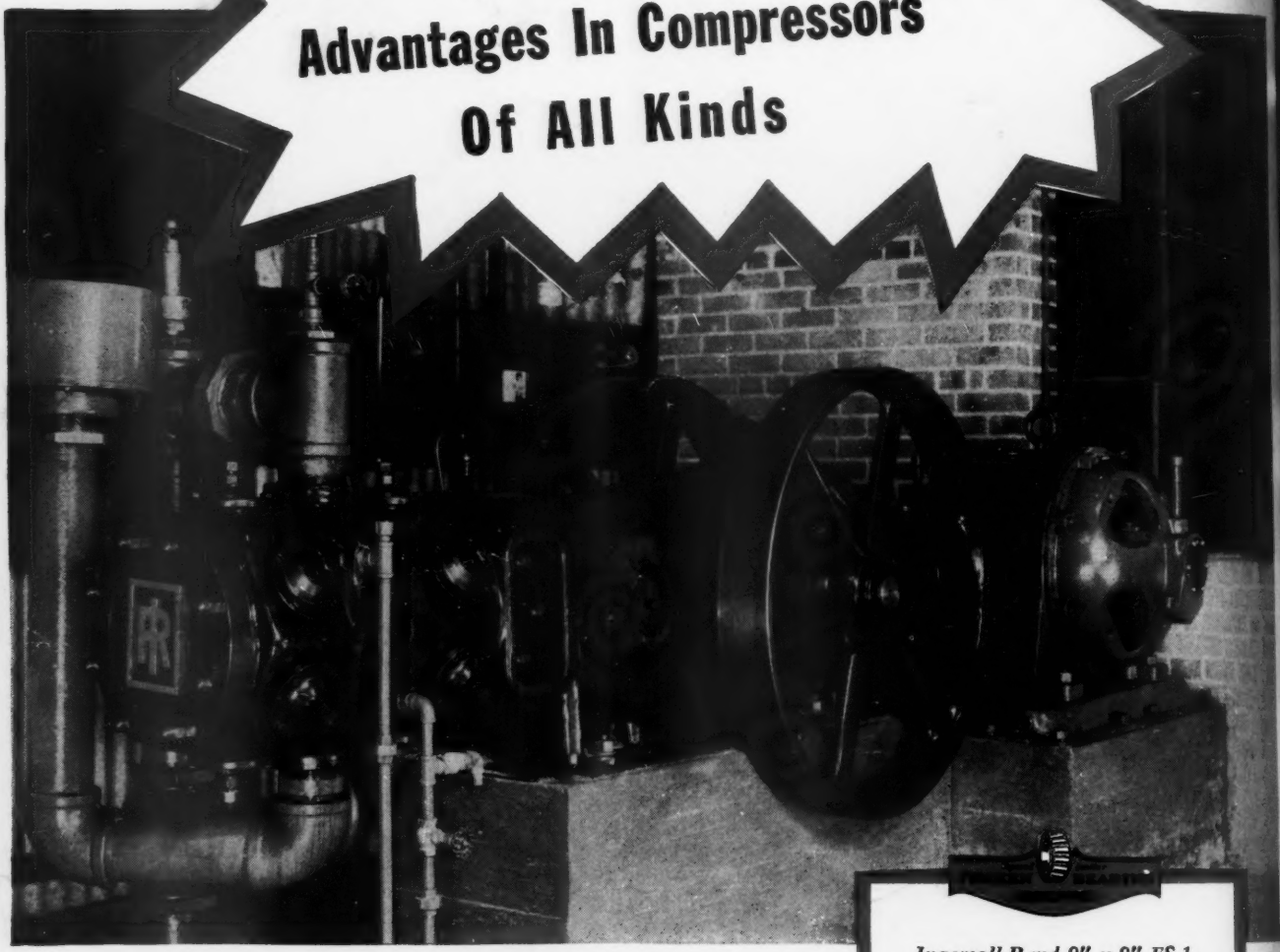

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Timken Bearings can give all these advantages because of their scientific design and precision manufacture. Furthermore, the tremendous strength resulting from the use of Timken Alloy Steel—of which all Timken Bearings are made—is a definite factor of increased endurance for the entire machine. Don't ask for an anti-frictionized compressor; *specify* and insist on Timken Bearing Equipped.

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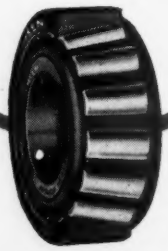
Ingersoll-Rand 9" x 9" ES-1 Air Compressor equipped with Timken Bearings on the crank shaft on air lift pumping service, town of Vidalia, La.



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